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No. CCXX.

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THE ELECTRICAL REVIEW

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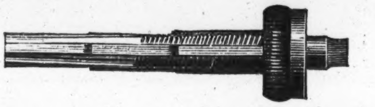

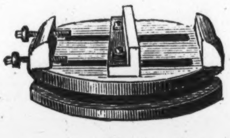

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THE TELEGRAPHIC JOURNAL AND
Electrical Review.
VOL. X.—No. 220.

THE UNITED TELEPHONE COMPANY
v.
MACLEAN.

"THE complainers are entitled to protection by interdict under Edison's as well as Bell's (Morgan-Brown's) patents." Such was Lord M'Laren's judgment in the recent action decided in Edinburgh, and brought by the United Telephone Company against Alexander Maclean, a Scottish telegraph engineer and electrician, for infringement of patent-rights under Edison's and Bell's specifications. We do not intend at present to enter fully into this action regarding the scientific and legal questions involved.

The decision could scarcely be other than it is when the arrangements of the whole case are taken into account. It was probably intended to operate as a precedent with a view to deter other alleged infringers of the telephone patents from carrying on their operations; and, if so, we do not feel at all sure that this end has been attained. Why, in all fairness, when so many people in London are making and selling telephones, the complainers, whose headquarters are in the metropolis, should have gone to Edinburgh for the purpose of trying to establish their precedent, we are at a loss to understand. But if we look at it in another light, they may be credited by their opponents with consulting the convenience of their chief witness—Sir W. Thomson—or even in the hope of indirectly enlisting his great local popularity and social influence on their side; but we do not suppose that either of these considerations entered into their calculations.

They more probably anticipated a less stubborn fight in Edinburgh than that which they would certainly have encountered here; and in this anticipation they were, as a perusal of the evidence suffices to show, perfectly justified.

But whether such a comparatively easy victory will in the long run be an unalloyed advantage to the complainers is, to our minds, very doubtful; and we shall not be surprised if they find it necessary to carry the question as to the validity of the Bell and Edison patents into the courts of law at Westminster, both sides being armed with a more formidable array of capable and personally-disinterested electricians than appeared during the late trial.

On neither side, in Edinburgh, was the professional evidence of that combined independence and strength, which in so important a case, and one possibly involving such vast interests, would have been desirable. There was, of course, on the part of the complainers, the inevitable witness-by-profession. In the present case this post was filled by Sir F. J. Bramwell, who stands at the head of that distinguished branch of the patents legal profession. We believe, however, that this is the first patent case in which we have had he pleasure of seeing Sir Frederick pose as an authority on electrical science; and, on the principle that all thing must have a beginning, we are not disposed to look too minutely into any little points in which Sir Frederick's interpretation of electrical phenomena might chance to differ from that of authorities on electrical science who, by force of habit, have got themselves into a mental groove from which he is free. Sir Frederick Bramwell is a man of practical common sense in practical common things, and is rather to be classed as a pupil of that older school of engineering which produced good work from elementary principles, than as belonging to the more recent development which bases engineering upon a sound physical and mathematical education. So far as Sir Frederick's opinions in such a matter as the dispute in question go, we should feel the greatest confidence in his intimate knowledge of the intricacies of the patent law; this, and his near relationship to a distinguished member of the bench would, had we been the presiding judge, have perhaps bespoken more attention on our part to his view of the case than any special qualification of his that we are aware of for expounding electrical principles.

In Sir William Thomson the complainers produced a witness of a totally different calibre. At the head of electrical, if not also of physical, science, Sir William's opinion would everywhere, and notably in the Scotch capital, carry an extraordinary weight on whichever side he took his stand; but we think he might as a general rule be more profitably employed in the interests of science than when subjected to the diversion of a cross-examination. In this telephone case, however, Sir William was very peculiarly placed, no small portion of the case for the respondents depending upon publication by him at the British Association meeting in September, 1876, of the invention, previously confided to him by Prof. Graham Bell, who did not patent it in England till the December following. We do not suppose for a moment that Sir William Thomson would knowingly allow his mind to be unduly biassed in this or in any other matter; but it needs a very small knowledge of human nature to decide upon which side his sympathies, and much more than his sympathies, would lie. By an oversight, a misunderstanding, or an involuntary indiscretion, Sir William prematurely published (whether clearly or not we will not now discuss) Bell's invention, and thereby very nearly did him, if he has not in the end actually been found to have done him, a very serious injury. To prevent or repair to the utmost in his power this actual or possible injury would be to a high minded man, such as by universal consent Sir William Thomson is, the first sentiment which would consciously or unconsciously move him. It may be due to imperfect reporting; but if not there are some points in Sir William's evidence which do not appear to be quite clear. When Sir William Thomson saw in action and admired Bell's early diaphragm speaking-telephone in America, and went so far in his admiration as to say, "the thing was done," Bell gave him the telephone, which he brought to England, set up in his laboratory, and exhibited afterwards to the public. Yet, with all Sir William's vast mechanical and electrical knowledge, he tells us that "Bell told him nothing which would enable him to make a telephone" . . . . . "and that he did not get any instructions from Bell which would enable him to fit it up and make it speak." Then what did Bell give him the telephone for? If the telephone was given for his museum as an historical curiosity only, and not to be used, why did Sir William try and put it in action? And if it was given with a view to making it speak in his laboratory, what possible object could Bell have had in withholding all instruction, or what possible delicacy could Sir William have felt in asking how he should proceed in order to make it speak? This passage in Sir William's evidence is self-contradictory, unless we assume that the telephone which Bell "would hardly call an invention, but which might ultimately become an invention" was, notwithstanding his professed enthusiasm, a matter of comparative indifference to the eminent Scotch Professor as regards its mechanical and electrical details. If so, he must have brought it before the B. A. meeting as a mere sensational curiosity. That Sir William Thomson had not carefully studied the mechanical and electrical details of the instrument which was in his hands, and which Bell most naturally would have supposed he could comprehend at a glance, is highly probable, because Sir William acknowledges that he failed to make it speak, and Mr. Conrad Cooke (a witness for the respondent) confirms this by saying that when he saw and examined the telephone at the B. A. meeting it could not work because there was a fault in the connections. In the face of this it might naturally be expected that Sir William Thomson's explanation of the instrument to the members of the British Association would, as he wishes us to believe, not be a very lucid one; but whether this was so or not, the construction of the instrument exhibited appears to have been sufficiently self-evident to enable Mr. Cooke to make a copy which gave articulate speech.

When Sir William Thomson tells us also that a membranous diaphragm did not suggest to his mind the notion of a metal one, we have further evidence of the cursory attention which he personally bestowed upon the matter. If Sir William Thomson means to tell us that the suggestion would not have been a most natural one, we can only say that his modesty does his great inventive powers a marvellous injustice, for we should from our present standpoint have thought that no ordinary electrician could have seen the one *in action* without the obvious suggestion of the other. It is, however, easy to be wise after an event, and the step between the two may possibly be wider than it seems.

Professor Fleeming Jenkin's evidence was also given on behalf of the complainers, and needs no special criticism, as we should scarcely be prepared to find Mr. Jenkin disagreeing in any particular from Sir Wm. Thomson. Of the two remaining witnesses it is also unnecessary to remark upon

The evidence for the respondent was confined to that of Mr. Conrad Cooke and Professor Blyth, neither of whom showed to advantage under the cross-examination, this however might also have been true of several witnesses for the complainers had they been subjected to the same ordeal. In fact the complainers' witnesses may be said to have escaped cross-examination altogether, and their evidence is therefore unchallenged in many important points, whilst Messrs. Cooke and Blyth were severely handled, and in the end apparently committed themselves to admitting points which they negatived in the beginning. Mr. Cooke, however, who is certainly an important actor in this telephone matter, may probably have something more to say yet, and that under more favourable circumstances.

We cannot at present analyse the speeches of counsel on both sides, but we do think that had Mr. Mackintosh subjected the witnesses for the complainers to cross-examination with the same amount of acumen and ability as he showed in his long and ingenious speech for the defence, the victory of the United Telephone Company might have been materially modified. But as we observed at the beginning, the result must have been foreseen, for the respondent was too weakly armed to oppose such a gigantic adversary with any chance of success. We shall in a future article deal again with this matter, and by that time our readers will be in possession of all the evidence, addresses of counsel, and the summing up and opinion of the presiding judge, Lord M'Laren, in this important case.

THE UNITED STATES PATENT OFFICE.

BY order of Commissioner Marble, United States Patent Office, all United States patents appertaining to or bearing upon electricity granted prior to July 1st, 1881, have been reprinted and the drawings thereof reproduced and bound up in neat substantial quarto volumes of about two thousand pages each. There are sixteen such volumes, the subject matter of each being of such sub-classes as naturally relate to each other, thus giving in each volume a full *résumé* of the state of the art from its origin to date. There were issued to, and including, the above date, 3,825 such patents, which are subdivided into sixty-nine sub-classes.

A brief glance at these sub-classes reveals the fact that the most activity has been exercised within the following during the past three years: 1, electric lights; 2, dynamo-machines; 3, telephones and their appliances. Prior to January 1st, 1878, there were only twenty patents on electric lights; July 1st, 1881, there were 192. Prior to July 1st, 1879, there were only nineteen dynamo and magneto machines. July 1st, 1881, shows 111.

The first telephonic telegraph patents were granted in 1875, and before January 1st, 1878, they numbered less than two dozen. Now they embrace the subject matter of two of the above volumes and constitute in all eight subdivisions embracing all kinds of telephones, telephone telegraphs, alarms, calls, appliances, &c., all told, 438 patents.

The division of electricity has grown to be the largest in the patent office, with an average monthly showing of over two hundred new applications. Some idea may be formed about the interest manifested in America as to the future of the electric light when it appears that there are now pending over three hundred applications for patents on various features thereof, a large majority of such applications being for what is known as incandescent patterns and their appliances.

There is also much interest manifested in relation to the Faure secondary battery, and applications are pouring in upon that subject, but as yet nothing appears to be any advance upon what Faure has done. There is, however, as much interest developed in dynamo machines, and there are at present pending over 150 applications.

A large interest is also apparent in telephones and telephone exchange systems, and there are pending over two hundred applications on these devices.

In duplex and multiplex telegraphy there has been but little advance, but there are pending applications for patents for several valuable inventions.

In telegraphs and telegraph apparatus but slight advance is apparent, the leading inventions being in the applications of dynamo instead of batteries for telegraphic purposes.

Vol. I.

United States electrical patents to July 1st, 1881:—

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69 Classes.	Grand Total	3,825

Our readers will see from this interesting collection of matter on the American patents what importance the subject of electric lighting has assumed in the United States, and this is still more intensified by the large number of applications now awaiting examination.

Electric lighting by incandescence appears to occupy the majority of minds as it does in England, and although many of the inventions may be worthless, yet the numerous specifications show that the present systems of domestic illumination by gas and other lamps will gradually be superseded; for, with so many inventors seriously at work on this subject, it seems evident that success will shortly be attained. The only point now to be got over appears to be that of economy as compared with gas, &c.

The following notes on the examination of the application for patents will also be read with interest.

During the year 1881 nearly 16,000 patents were granted in the United States, a larger number than was ever granted before in this or any other country.

This would seem to indicate increased inducements to special inventors in certain lines of invention were it not for the fact that a careful study of their special classifications adopted by this patent office shows no marked increase in any particular class, with one single exception, viz. electricity.

The American system of examination as to novelty, utility, &c., and of protecting meritorious inventions stimulates inventors, and the history of the Patent Office shows with marked clearness that increased annual grants of patents depends almost exclusively upon the financial condition of the country, thus indicating that inventions are commensurate with the necessities of the times. In the class of electricity there has been remarkable energy displayed, and the commissioner has found it necessary to divide the classification within the year by transferring to other divisions of the examining corps such details as could be properly spared, and yet not materially affect the class proper.

It has been the practice in the Patent Office to observe with the greatest strictness a proper classification, and to this end only such details as gas lighting devices, electrical registers, conductors, insulators, and, in short, those devices not purely electrical in their nature have been lopped off. There are now employed in the electrical division one principal examiner, seven assistants, and three clerks, a larger force than in any other division in the office, and yet it has been found necessary to make the transfers above noted in order that the work might be kept up. On the above force there devolves the duty of examination as to novelty, utility, operativeness, &c., and oftentimes careful and accurate experiments are made to prove the assertions alleged in descriptions of inventions.

Lengthy searches touching the novelty of inventions are daily made through English, American, French, German, and other patents, and so careful is this search that fully fifty per cent. of the applications never go to patent, or at best with but limited claims, the patentee's invention resting almost exclusively on his claims. As fast as possible the examiners are briefing or abstracting foreign patents with a view of making searches less laborious, and great care is being exercised in classification of patents already issued, so as to afford easy search. The American system of interferences is somewhat peculiar, and operates upon the principle that only he who is the first inventor can obtain a patent, and even though one has obtained a patent he may be put in interference with one who comes after, if the latter proves himself the prior inventor and if certain other statutory bars do not preclude him. For this reason the question as to who is the first inventor of the telephone is still unsettled, and the same is true as to the successful quadruplex systems of telegraphy, even though they are well known and in successful operation. These questions must all be settled before the inventor can claim a valid patent, and then he relies upon the courts to sustain said patent, which is in itself *primâ facie* evidence as to its validity. The courts construe the patentee's claims in view of his specification and the state of the art as existing at the time said patent was granted, so that it may be declared invalid by a sufficient showing as to lack of novelty or as to full compliance with statutory requirements.

The question of original inventorship of the telephone is now before the examiner of interferences, and will doubtless be appealed by the losing parties to the commissioner of patents, no matter in which way decided, in view of the fact that so much is involved and the testimony so conflicting. And even when the patent is granted there will be the same war waged in the courts, so that to all appearances it seems interminable.

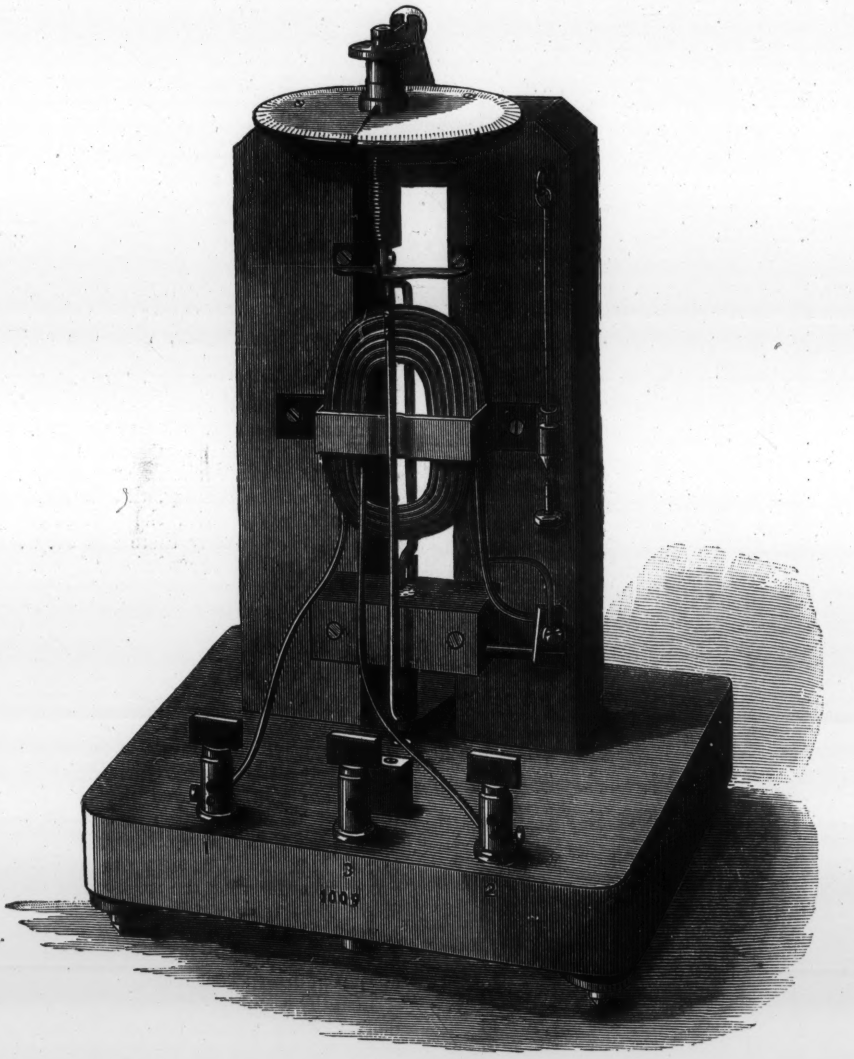


Fig. 6.

ELECTRIC LIGHT MEASUREMENTS.

By H. R. KEMPE.

IV.

Electro-Dynamometers.

For measuring currents whose direction is always the same the apparatus which has been described answers every purpose. In cases, however, where *alternating* currents (such as are employed in the Jablochkoff system of electric lighting, for example) have to be measured, an ordinary galvanometer would give no indications; in such cases a dynamometer must be used, as the deflections given by this instrument are always in the same direction no matter what currents traverse its coils. The principle of the dynamometer is based upon the mutual action of currents upon one another, *i.e.*, upon the fact that currents in the same direction attract, and in opposite directions repel, one another.

Fig. 4 shows how the principle is applied. A B C D is a fixed wire rectangle, and *a b c d* a smaller one, suspended within the larger, so that it can turn freely about its axis; the planes of the two are at right angles to each other. Now, if the two rectangles be connected together in the way shown, then a current entering at W_1, and passing out at W_2, will traverse the two, and the current passing from B to C will attract the current passing from *a* to *d*, and will repel the current passing from *c* to *b*. A similar action takes place with reference to the current passing from D to A, consequently the smaller rectangle, under the influence of the forces, will tend to turn about its axis, in the direction in which the hands of a watch rotate. If the current enters at W_2, and leaves at W_1, then, inasmuch as the directions of all the currents in the wires are reversed, the small rectangle must still tend to turn in the direction indicated. If one or both of the rectangles consist of several turns of wire, the turning effect for a given current will be proportionally increased.

Fig. 5 shows the general arrangement of a dynamometer for measuring currents, &c. The instrument consists of two coils of wire, C_1 C_2, within which is hung by two threads,

t_1 t_2, a small coil, *c*; the wires from the latter coil are in connection with the large coils, &c., through the medium of mercury cups. The bifilar suspension, t_1 t_2, serves to give the force against which the current has to act in order to turn the small coil through different deflections, which deflections are seen by the indicator, *p*, moving over the scale, S. The values of the deflections, in terms of the degrees of deflection given by such an instrument, can be obtained experimentally. The simplest way to do this is to join up the instrument in circuit with a tangent galvanometer, a set of resistance coils, and a battery, then to put sufficient resistance in the circuit to obtain one division deflection on, say, the tangent galvanometer (the reading being on the *tangent* scale of the instrument); next to shunt the coils of the dynamometer until the deflection on the scale of the latter is reduced to a deflection sufficiently small to represent the division. If it should happen that the tangent galvanometer is the more sensitive of the two instruments, then it will be the tangent galvanometer which will require the shunt, and not the dynamometer. Having, then, obtained the needles of the two instruments at deflections, representing one division each, and having marked the dynamometer scale, the resistance in the resistance coils should be diminished until the needle of the tangent galvanometer points to *two* divisions. A mark should then be made at the corresponding deflection given by the dynamometer pointer; the resistance in the resistance coils should then be still further diminished until the pointer of the tangent galvanometer stands at *three* divisions, and then a corresponding mark should be made on the scale of the dynamometer, and so on. Thus by obtaining the deflections of the tangent galvanometer at each division successively, and making corresponding marks at the corresponding deflections given by the dynamometer pointer, the scale of the latter instrument can be accurately graduated. It is not absolutely necessary to employ the tangent galvanometer for thus *calibrating* the scale of the dynamometer, for if we know the resistance of the coils of the latter, and also the resistance of the battery, we can easily calculate what resistances we must put in circuit to obtain currents of the relative strengths 1, 2, 3, &c.

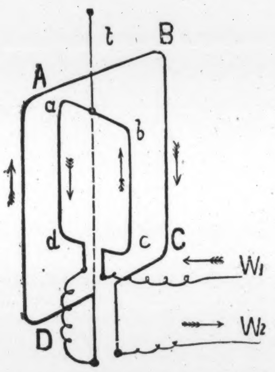


FIG. 4.

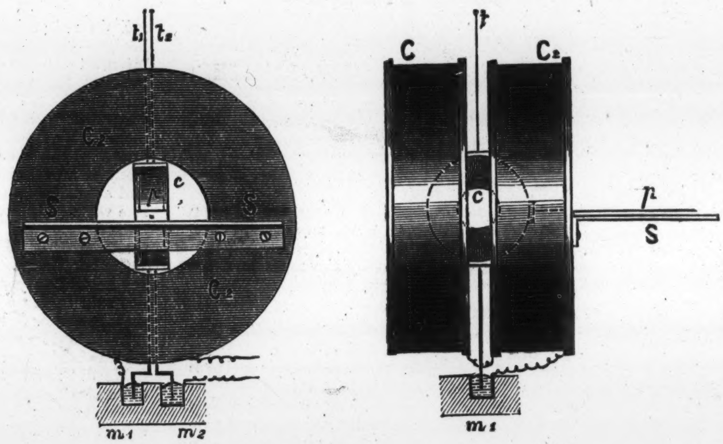


FIG. 5.

Although for certain purposes it might be advantageous to have the whole scale of the instrument graduated, yet as has been pointed out in the case of measuring currents by the tangent galvanometer, it is not advisable to use either very high or very low deflections, but to obtain those of a medium value; this can be done by means of the adjustable resistance coils, as explained in Articles I. and II.

It might perhaps at first be anticipated that the deflections produced by various currents on the dynamometer would have about the same relative magnitudes as regards their number of degrees of divergence as the deflections on the tangent galvanometer; that is to say, for example, if two currents on the tangent galvanometer gave deflections of 10° and 40° respectively, then it might perhaps be imagined that if the smaller current also gave 10° on the dynamometer, then the greater would give about 40°. This is not the case, however, for the following reason: In the case of the tangent galvanometer we have a magnetic field formed by the magnet of a fixed intensity, and this is not altered by the action of the wire coil; in the case of the dynamometer, however, the magnetic field of the movable coil is increased directly as the current is increased, thus if the current passing through the deflecting coil is doubled, then the current passing through the deflected coil is doubled also, consequently we have a doubled current acting upon a magnetic field doubled in intensity, and, therefore, we must have a quadrupled deflective effect—in other words, the deflective force tending to turn the movable coil will vary as the *square* of the current, and not directly as the current, as in the tangent galvanometer.

SIEMENS' DYNAMOMETER.

A general view of this instrument is shown by fig. 6. It consists of a rectangle of wire hung from a spiral spring whose upper end is fixed to a thumb-screw provided with a pointer, which can be moved round a graduated dial. The number of degrees to which this pointer points evidently indicates the amount of tension given to the spiral spring. To the rectangle also is fixed a pointer, the end of which just laps over the edge of the graduated dial. The rectangle encircles a coil consisting of several turns of thick, and a larger number of turns of thin, wire; the two ends of the thick wire are connected to terminals 2 and 3, and the two ends of the thin wire to terminals 1 and 3. Connection is made between the rectangle and the wire coils by mercury cups, into which dip the ends of the wire forming the rectangle. The base board has three levelling screws; the level consists simply of a small pointed weight hung at the end of a rod (seen on the right of the figure), the pointed ends hang exactly over a fixed point when the instrument is level.

The method of using the instrument is as follows:—The wires leading the current whose strength is to be determined are connected to terminals 1 and 3, or 2 and 3, according as a strong or weak current has to be measured. The current deflects the rectangle; the thumb-screw is now turned in the reverse direction to that in which the rectangle has turned, and torsion being thereby put on the spiral spring the rectangle is forcibly brought back towards its normal position—that is, at right angles to the coils, or to the position at which the pointer attached to the rectangle stands at zero on the scale. The number of degrees of torsion given to the spiral spring being then read off, the strength of the current is found by reference to a table supplied with each instrument. To construct this table a current of a known strength is sent through the instrument, and then the degree of torsion required to bring the rectangle back to zero is carefully noted. This being done, the currents corresponding to other degrees of torsion are easily calculated. The force of torsion varies directly as the number of degrees through which the spiral spring is twisted, whilst, as has been before explained, the deflective effect of the current varies directly as the *square* of the latter. In other words, if ϕ° be the number of degrees of torsion required to bring the rectangle back to zero when it is traversed by a current of γ ampères, then, if γ_1 be the current which will correspond to any other degree of torsion ϕ_1, we have—

$$\phi : \phi_1 :: \gamma^2 : \gamma_1^2$$

or—

$$\gamma_1 = \sqrt{\frac{\phi_1 \gamma^2}{\phi}}$$

Thus, for example, if 180° (ϕ) of torsion were required to bring the rectangle back to zero when it was traversed by 47·57 (γ) ampères of current, what current (γ_1) would be represented by 80° (ϕ_1) of torsion ?

$$\gamma_1 = \sqrt{\frac{80 \times 47{\cdot}5 \times 47{\cdot}5}{180}} = 31{\cdot}7$$

(*To be continued.*)

THE TELEPHONE CASE.

In the High Court of Session. First Division, Edinburgh.

Before LORD M'LAREN.

THE UNITED TELEPHONE COMPANY, LIMITED,

v.

ALEXANDER MACLEAN, EDINBURGH.

(*Continued from page* 82.)

As far as you have been able to theorise, these things are common to the two cases?—Yes; they are common to the two cases, but at opposite ends of the scale.

THE COURT: You think that compression by the mass is not a material agent?—No, my lord.

CROSS-EXAMINATION CONTINUED.

You have studied the figure ten in Edison where he describes that plumbago contact point; that is what you refer to?—Yes.

The degree of pressure will vary as to the form of the carbonic materials, and in that you have told us the things that may be common to the operation of the two; is there any one thing that you can see in the action upon the carbons in Edison's which is not also present in Theiler's, and *vice versâ*?—I understand this question as relating to one place—the electric-tension regulator.

When was the phrase "shaking contact" introduced into scientific language?—I do not know.

Is it introduced yet?—No; I use it to explain my views.

You are aware of the plumbago pencil points. Do you think the gas carbon pencil was an equivalent for the plumbago points—would you consider it so?—The two substances are not opposed in one respect, namely, the degree in which the two forms of carbon possess certain qualities.

You described pinching the carbon pencils; where did you do it?—Endways; the end was clean and a fine wire was made bright, and it was tight, and the point of contact between the carbons was not rigid.

You did not pinch the wire against it?—No; I did not wish to do so.

Would Theiler's transmitter, or the one used by the respondent, do equally well if the voice was left to go by an open hole direct to the carbon pencils?—Yes; I think so. I think it would speak as well with the door open as with it shut.

But you have no theory to account for him putting on these additional articles?—I do not know any except to make it a saleable article.

Was the mouth-piece put on just to take in the public?—Well, really that was my opinion.

You spoke of Crossley: I suppose the answer you have already given with respect to Hughes' microphonic pencil will also apply to Crossley's?—Yes.

You can transmit the speech by nails?—Yes; coupled up as Theiler's is.

He never did it by nails, and is that because carbon is better than nails?—I suppose so.

You showed us a cork apparatus which seems also to be two carbon plates in proximity?—They are not in contact. I speak of the lower pair with the division separating them, and that is bridged over by another piece of carbon similar to the cross beam in the other two.

So that what was remarkable to the others would probably be true of this also?—Yes.

Who is using this?—The respondent.

Has it sold commercially anywhere?—Not that I know of.

Then it is a mere philosophical toy?—I don't know.

MR. SALVESEN: I understand it is a philosophical toy, but a saleable article.

CROSS-EXAMINATION CONTINUED.

Are you serious in saying that Theiler only put on the cork to muffle or detain the sound?—Yes.

Where had the sound you were afraid of generated; and was it to muffle the sound that came from the diaphragm?—To muffle the sound from the voice through the telephone.

Wherever you find the grating noise, it indicates that the contact has been broken?—It indicates that the sound is too near or too loud for the adjustment of the transmitter, or that the contact is too light.

Then the cork of Theiler's would be put behind his metal diaphragm for precisely the same purpose as Edison tells you you may put the soft diaphragm at a point behind the transmitting and receiving diaphragm?—Yes, I gave a definition of a diaphragm which involved that it was always fixed at the edges.

What authority do you find in Edison's specification for saying that a tympan must be under tension?—By calling it a tympan.

But where do you find any indication that the metal must be under tension?—Because it is already rigid.

And therefore you don't need it under tension; but what is your reason for saying that Edison, when he referred to metal tympans, requires that they must be under tension?—By the use of the word tension. If it were glued round the edge and free in the middle it would be a tympanum.

Then in your judgment is it essential to a tympanum being within Edison's patent that it should be nipped all round its compass?—Yes, I think so. It would not be Bell's tympan if it were not held all round.

You illustrated the uselessness of metal plate in Theiler's instrument by saying it was merely like a coat of paint?—Yes, and that it would be much simpler to dispense with the whole thing.

THE COURT: I understood you to say that you expressed in your paper in *Engineering* that Edison's carbon transmitter was a very valuable invention?—Yes.

Is that the one described in his patent?—No, it was not. It is a subsequent invention, in 1878.

CROSS-EXAMINATION CONTINUED.

I do not think that Reiss, Gray, and La Cour anticipated Morgan-Brown's patent. In the case of all these they were intended for the transmission or reproduction of musical sounds, but not for transmitting words and sentences as well. These telephones had not been used for commercial work, but they formed a germ which might be developed, and which Bell developed more than anybody else. In my first article one of these telephones was kept in the experimental room, and the other placed in the basement of an adjoining house. This applied to an apparatus which had a membrane diaphragm at each end, with a battery through the line wire. My first knowledge of the use of a metal diaphragm was gained from Sir William Thomson, at the British Association meeting.

Sir W. Thomson had not communicated to anybody else what you say he said to you about the keeping down of the lid?—No; it was not said in his address. There were several present when he told me—Professor Sylvanus Thompson and others.

What did he say about it?—He said that when it was in action the lid was held down tight; that was all.

He did not say how it was to be held down, whether by hand or otherwise?—

THE COURT: I cannot hold that a cautious remark of that kind amounted to a declaration of electric action.

CROSS-EXAMINATION RESUMED.

Sir William did not tell me that if the lid were pressed down too hard it would kill the sound. He simply said that when the apparatus was in action the lid was held down. I did not disclose that point in my article to the public.

Was it not an after-thought?—No; I did not think of it at the time. I did not understand it when I wrote the article in *Engineering*. I did not understand that it acted in the way it does—I did not understand its working, but I knew that the lid was held down. What Sir William told me, and the opportunity I had of inspecting the instrument did not enable me to comprehend how it could be made to work. At the time I wrote the article I did not understand why the holding down of the lid was a necessary feature.

But did you understand that that was important at all?—I knew that when it was in action it must be in that position.

Did you think that was accidental or essential to its operation?—At that period I really could not and did not know the action of it. I did not know at that time that the lid pinned down at that place was just a musical tongue.

Was there any vibrator then known in telephones except one, that was free as a musical tongue is free?—Reiss's would, but it is quite different.

At that time was the idea of a tympanum held down all round becoming a vibrator, either for transmitting or receiving, known about?—No.

Did you know of any metal vibrator at that time used in connection with telephones, except one that was attached at one point?—Oh, yes, Elisha Gray's; but I think I simply repeated Sir William's own explanation about these vibrations. I say now that it is one of the most incomprehensible and marvellous things that a disc of iron can reproduce all the marvellous effects of the tongue; and that, had I not heard it on the authority of Sir William Thomson and other reliable persons that they heard it distinctly, I should have been inclined to doubt it. I should have thought that the account of the clearness of articulation was an exaggeration, but when a man like Sir William Thomson stated it, I was bound to believe it. When the experiment with the model was tried it was in the same condition that it is in now (model produced). Its failure to work was immaterial if that was due only to some internal disarrangement of the machine. (A screw having been removed from the model, the experiment to show its working was repeated, successfully, with the electro-magnet.)

Are not you satisfied that the action was present in that apparatus which you thought was absent just before luncheon?—It was absent before luncheon.

No, no, it is simply that Sir William Thomson's electro-magnet is more sensitive than your own galvanometer with which the former trial was made.

The Court thought that since this point had been raised, he thought the galvanometer should again be applied now that the screw was removed.

This was done, but without producing the desired effect.

Examination continued.

Is it not the case that your galvanometer is one intended to be affected by large coils, and not at all by small ones?—I don't think so.

Is it not evident that the action does exist when Sir William Thomson's electro-magnet is applied?—Yes, I see that now; but I cannot see how I was mistaken.

It does not affect your galvanometer now; and does not that show that your galvanometer is not sensitive to feel what will affect Sir William Thomson's instrument?—Certainly.

And so the current is actually passing there?—Yes, it must be.

Does it only vary in the method of holding down the diaphragm; is it material whether the diaphragm is held down by a screw only at one point or all round?—It must be held down all round.

Is not that a material difference?—The magnetism holds it down.

Till Morgan-Brown's pamphlet came out had you become aware of the virtue of a metal diaphragm attached all round its circumference?—No.

About the phonograph—that is, an apparatus the main function of which is to reproduce recorded sounds. If it recorded without reproduction it would be unimportant?—Yes.

Now, your criticism, I think, of Edison's specification depends on the supposition that recording is a misprint for receiving?—Yes.

The Queen's printer's copy, while it corrects some small mistakes, continues the recording. In this passage does not that lead you to the conclusion that the original written copy must be recording?—Well, I cannot think it was intended for recording.

Do you find any portion of any apparatus described in the final specification, except the phonograph, which may be available in transmitting or recording?—No.

And that is interchangeable for transmitting or recording?—Yes.

Then you say further some portions can be made use of to make a record of atmospheric sound waves, and the phonograph can so be used?—Yes.

And you see from both the provisional specification and the final specification that that apparatus is intended to be used as part of the telephonic apparatus?—It is applied in the one case, and I know now that it can be done. I am aware that it can be put at intervals and made to record messages received, and then transmit them further along the wire, and that is an ingenious invention.

Re-examined by Mr. Salvesen.

The difference between the designs is that in Edison's diaphragm the motion is produced by push and pull vibrations, whereas in the respondent's transmitter it is produced by sympathetic vibrations?—Yes. My view is that the compression theory must be thrown aside because gas carbon is incompressible in the sense that it does not vary to a sufficient extent to affect the current.

And I think that with reference to surface pressure what you say is that while it undoubtedly does enter into the explanation of the microphone it will not account for it in the way indicated in Edison's law of proportion?—No. I cannot say it would be excluded from the physical law.

And you would say popularly that you explain the action of the microphone by delicacy of contact?—Yes.

Is it not the case, Mr. Cook, that you maintained your own theory from the beginning of the Edison-Hughes controversy, and that you still hold it?—Yes; and I believe it is the theory now generally adopted. In fact, before Hughes published it I had that idea, and I have been familiar with it since its commencement. If the tympanum is of a flexible material it must be under tension to keep it flat, but if a rigid material it will keep flat without tension.

In the most delicate form of the microphone exhibited by Professor Hughes in his first lecture, is it not the case that there was no diaphragm, and yet it transmitted speech, even very low speech, with perfect distinctness?—Yes.

Now, with reference to that receiver exhibited by Sir William Thomson, is not the tubular magnet perfectly well known, and would not any one getting a description of that magnet be able to construct it from the mere words?—Yes, and it was well known that the cylinder became magnetic whenever the current was passed through it; and in that way, whenever it became magnetic, it would attract the armature above it, and fasten it down all round the outer edge.

When Sir William Thomson told you that the disc was held down when in action, in what manner did you think that he meant the disc was held down?—I understood by magnetic attraction. At the time I wrote my article in *Engineering* I had, in point of fact, never seen Bell's telephone in action, but I think if I had seen it, the thing would have been quite obvious to me. I could have constructed the apparatus from hearing the descriptions given of it at the lectures.

The examination of this witness being concluded, the Court rose.

Friday, 27th.—The Court resumed at 10·30 a.m. The first witness called was

Professor Blyth, who, examined by Mr. Salvesen, deposed: I am a Fellow of the Royal Society of Edinburgh and Professor of Natural Philosophy and Mathematics in the Anderson University, Glasgow. Since their introduction, I have paid great attention to telephones and microphones, and for several years I have made experiments in connection with them. I am acquainted with the 1877 patent of Edison, and have carefully studied the devices which he has patented there.

Do you see any anticipation in that patent of what is known popularly as Hughes' microphone?—No anticipation. I have seen Theiler's instrument. It is not an adaptation of the microphone of Professor Hughes. It works upon the principle of the microphone. I notice that Edison claims a combination of the diaphragm with an electric tension of regulators. The general character of the electric plates and regulator appears to me to be that of some easily compressible semi-conductor, and exactly of the character made out in this case, and the principle on which they work seems to be this, that the variation of resistance of this electric tension regulator is produced solely by the pressure exerted upon it, and that the variation of resistance is due to the change of density throughout the mass of the electric tension regulation, the variation of tone being produced by the tympanum.

Does he select always for his regulators something more or less elastic, or a non-elastic material?—Something whose resistance can be varied by this change of pressure.

Is that in your opinion the principle on which the microphone and Theiler's instrument work?—No, it is not the principle on which they work.

I suppose it would be correct to say that compression of the mass of the carbon pencils and also compression of the surface takes place in the action of the microphone?—Well, there will be a slight compression. In a mathematical sense there may be a slight compression, but I do not think that either of these causes is sufficient to explain the action of the microphone.

What do you say with reference to density?—There is a variation in the density of the gas carbons. The variation in the density does not explain the variation in the electric current, for in my experiments with gas carbon, I have tested with the view of ascertaining whether there is a variation to this extent through the passage of a current in a piece of gas carbon, by a considerable pressure put upon the carbon in the direction in which the current is flowing through it; and I found that it will not produce such a variation with a moderate pressure. It cannot be produced except with a very severe pressure, such as would produce crushing. These experiments were made by me two and a half years ago, and I am quite satisfied as to their correctness.

Would you kindly explain the nature of the experiments which you made?—In order to find out if variation of resistance in a carbon stick was produced by additional pressure, I attached two leading wires to the carbon stick or pencil placed vertically. A current was led to the carbon pencil near the top, but not quite at the top, and the current was led out of the carbon pencil at a point near the bottom, but not quite at the bottom. The pressure was put on in a vertical direction—in the direction in which the current followed through the carbon pencil and the balance of the resisting coil—and I found no appreciable variation with a moderate pressure. I applied steady compression, placing weights upon the carbon. The second experiment was with reference to tapping, to find out what effect tapping would have in producing change of resistance in general, and I tried it (1) when the current was led through the carbon, and (2) when it was led through the junction between the pencil carbon and another piece of carbon at the top. With the first of these trials, I found no sound in the tympan; but when the current was led through the junction I found that sound.

Then gas carbon, in your opinion, differs from the tension regulators described by Edison in this respect, that it does not vary its resistance to the passage of a current of electricity when pressure is applied, whether at the surface or throughout the mass?—It does not vary its resistance by a change of pressure throughout the mass. There is a variation of the resistance to the current when it passes through the junction of the one carbon to the other.

The Court: Did you make your test with the galvanometer?—I used the galvanometer with the first experiment to test the change of resistance with the carbon stick; and I applied the galvanometer at first to the second experiment, but I thought the telephone was the best for that. With the galvanometer there was a general shaking, and I thought the telephone a better mode than the galvanometer of testing any sudden change that would be produced.

Examination resumed.

There was a general shaking when the current passed through the joints. The telephone was a more delicate instrument for my purpose than the galvanometer.

In Edison's specification there is a passage with reference to proximity or extent of surface contact. What do you understand by that?—I can make no intelligible meaning out of the words proximity of surface contact, because when there is proximity there cannot be surface contact, and when there is surface contact there can be no proximity. Where proximity ends, contact begins, and mere proximity would never produce any deviation in the current.

Look at the context. Do you see where he speaks of a greater or less intimacy of contact?—As far as I can make out the meaning of that, which is not at all clear to me, the variation of intimacy of surface contact can only be due to pressure. I cannot see anything else.

It works upon the same principle as the rest of Edison's regulators. There is no doubt, however, that to a certain extent in the microphone there must be a change in the number of points of surface contact when the pencil is moved?—Yes, but that is not sufficient to explain the difference in the working of the microphone, for I cannot see how the change of surface contact can be produced in such a way as to produce musical sounds. There are disturbing influences which would prevent the operation of the law of proportion.

What are these disturbing influences?—Speaking with reference to a number merely of points of contact, these points of contact are continually changing. That is one element, and one has great difficulty in seeing how that could be varied proportionally according to any law we know of.

Any other element?—With reference only to surface contact, there would be an electric current produced by friction. We cannot have two substances rubbing against each other without producing a certain effect of that character. I ascertained by experiment one or two years ago, that thermo-electric currents are produced when carbon pencils are rubbed against each other, and I communicated the results of these experiments to the Royal Society of Edinburgh.

Would another disturbing influence be the difference in the conductivity of the points of contact?—Yes, in a non-homogeneous material like carbon, the points of conductivity might differ at the points of contact.

As regards the explanation that the action is due to the variation in the number of points of contact by the variation of surface pressure, what is the result at which you arrive?—That that alone cannot explain the action of the microphone.

Speaking popularly, what do you consider the action of the microphone to be?—I am unable to say what the action is; but what appears to me to be the action is the delicacy of the make and break action. It acts through the delicacy of make and break. We know that an interrupted current does produce a musical sound, and we know also that the pitch of the note will depend on the frequency of the interrupting current. Now if we have a sufficiently delicate make and break, it seems to me quite possible, at least not impossible, that an expert might be able to transmit a speech, seeing that articulate speech has an accentuated sound.

You are still of opinion that that is most probably the action of the microphone?—Yes; of course I do not commit myself to saying, without further experiment, that that is the exact theory.

Is that view confirmed or not by the fact that sparks are noticed upon the carbon pencils of the microphone when it is seen in operation in the dark?—It is; I have seen sparks emitted from the microphone when it is being used as a transmitter, and that indicates that there is more or less of a make and break.

And you think that when there is a sufficiently delicate apparatus for making and breaking the current, there is no reason to suppose that it may not transmit articulate speech?—No reason to suppose that it may not transmit articulate speech.

By the Court: They were occasional sparks, and gave evidence of the break at the time I saw them.

Examination resumed.

The sparks may be so minute that they may not be visible, or you may not be at the point of view at which to see them properly.

Whatever the theory of the microphone may be, do you explain its action by the fact of the looseness of contact between the two carbon pencils?—It depends more or less upon the looseness of the contact. That is not a feature of the Edison transmitters: in fact, it appears to me that that feature is purposely and intentionally guarded against in Edison's.

Would it be correct to say that Edison seems to aim at as perfect contact as possible between the electrode and the electric tension regulator?—As perfect as possible; while Hughes' microphone depends essentially upon the looseness or delicacy of contact. I am aware that Hughes' microphone can be used as a transmitter without any diaphragm at all in the proper sense of a diaphragm?—Yes. I have tried experiments with the microphone where there was nothing but merely the table on which the apparatus was supported, and in that way I have heard transmitted articulate speech, but the object of my experiment was not to find out the best form of speaking instrument. My object was purely scientific, and if I could hear articulate speech, my object was satisfied. I tried it with a jar filled with cinders.

And with such a contrivance as a jar filled with cinders, and connected with another forming the battery, you did get articulate speech transmitted?—Yes.

But I suppose the carbon sticks and the loose contact serve exactly the same purpose as the cinders in like contact in a jar?—Exactly; I tried a number of experiments in reference to the action of the microphone, and I communicated the results to the Royal Society. I have seen the Theiler instrument used by the respondent. I notice that there is a cork plate with an iron plate fastened in front of it. The iron disc does not act as a tympanum, because it is not of the nature of a tympanum. The tympan must be bound round its circumference, and be able to move in a push and pull movement in its centre, and the iron disc in this instrument is glued all over. The cork there might be called a tympan, but in its action it is not meant and does not act as a tympan.

Would the iron disc upon the cork to any extent affect the value of the cork as a tympan?—Yes.

Surely it is not maintained that cork can act as a tympan—that it has acoustic properties?—

The Court: I do not think either Sir Frederick Bramwell or Sir William Thomson suggested that cork had any effect on the sound. I think they said it acted merely as a damper.

Examination resumed.

Do you regard the cork as in any sense a tympan, and would its action be improved or not by the fact of its being loaded in the centre with the iron disc?—It would not be improved. I believe it would be made worse.

How, in your opinion, does Edison's tympan or diaphragm work?—So as, by the to and fro vibration, to produce these sounds by the push and pull vibration.

How would the diaphragm in Theiler's instrument act upon the pencils?—The diaphragm in Theiler's instrument acts upon the principle, I believe, simply of communicating to the pencil the tremor that it gets from the sound waves as they strike upon it, and the whole of the instrument is acting in that way. The whole of the instrument catches the sound waves, and if the instrument were inclosed in a plain wooden box without any mouthpiece or diaphragm, it would work, though less perfectly, possibly.

The microphone is a very delicate instrument, and in order to make it work well in articulate speech the sound requires to be dulled in a manner?—The make and break require to be regulated so as not to be too great, or you get a roaring sound. It requires a certain adjustment, and so it may be right to say that the sound is dulled down.

Would you say that the action of the cork in Theiler's instrument was to force the two carbon pencils attached to it against the third pencil?—Not to force it back, but to communicate a tremor to the whole three. The resistance of plumbago is variable under changes of pressure. It is a very different form of carbon from gas carbon. I could not make the instrument from the description given on the top of page 6 of Edison's specification. It is not clear enough to understand what the instrument is like. In the first place, it does not state what thickness of plumbago is to be put upon the instrument. There is no information given as to the way in which it is to be attached, whether glued or simply painted on.

Is there anything said about the material of the disc and the tympanum?—Not for the disc, and there is nothing about a coupling; and according as you make the disc of a non-conductor or a conductor you have to couple it in a different way. From what I gather from that description it is simply one of Edison's tension regulators in another form. I know the instrument called the phonograph, and have read the provisional specification of the patent of 1877.

Do you find any indication of the instrument known as the phonograph in that specification?—No, not as I understand it.

Looking at the passage beginning at the bottom of page 1 and continuing a little way down page 2, would you say that there is there an indication of the phonograph?—Not of the phonograph as I understand it. There is mention of recording, but an instrument for recording merely is not what I understand to be a phonograph. The essential characteristic of the phonograph is that it can reproduce from the record the sounds that were conveyed to it.

I suppose there had been instruments for recording sound prior to the provisional specification?—There was the phono-autograph.

Returning to Bell's receiver, I believe you were not present at the lecture given by Sir William Thomson at the British Association meeting in Glasgow?—I was not. I have read the entire publications founded on by the respondent in this case. These publications are prior to the date of that meeting.

Reading these publications and taking them in connection with Sir William Thomson's lecture and with the fact that the identical instrument was produced and exhibited at Sir William Thomson's lecture, would you say that you would have had any difficulty in constructing the instrument and making it from these descriptions?—I would not have anticipated any difficulty. I would have considered it possible for me to construct it. The tubular electro-magnet was a well-known instrument, and from the descriptions it would not have been difficult to effect the combination of the iron disc placed on the top of the tube. I have seen the instrument, the receiver, exhibited at Sir William Thomson's lecture, and copied into *Engineering*.

Taking the description in *Engineering* of December 22nd, what function would you expect the tubular part of the electro-magnet to play?—The function it plays is that it holds down the disc on the top of the orifice. It is a well-known fact that the tubular magnet becomes magnetic as soon as the current is passed into it. I have read Morgan-Brown's specification.

What is the difference between the receiver described on his fourth plan and the instrument exhibited at Sir William Thomson's lecture?—It seems to me that it wants this disc part of the electro-magnet, and it seems to be mechanically fixed in one of these instruments. I would say that that is a mere mechanical arrangement for fixing the disc down.

In your opinion, is the instrument beside you included in the sixth claim of Morgan-Brown's patent—the tubular instrument and transmitter?—It seems to me to be included in the sixth claim, and it is a combination of a plate with an electro-magnet.

Assuming that you had been acquainted with the so-called membrane telephone of Bell, and had been told that an iron disc could be used for the pole of the receiver instead of the membrane, how would it have occurred to you to fix that iron disc?—In the membrane telephone, knowing that an iron disc could be used and was better, I would have dispensed with the membrane.

Cross-examined by the Lord Advocate.

Then, Mr. Blyth, it would not, to you, have been a wonderful revelation that an iron disc could reproduce articulate sounds when other discs could not?—It would have been a wonderful revelation to me that any disc could produce articulate sounds.

But still you would have made the invention without any hesitation whatever after you knew that, and you had been shown that?—It is possible.

I am going to put a hypothetical question. You did not see the receiver or transmitter in September, 1876, but looking back upon the matter, and with your present knowledge, you think you would have had no difficulty, on the idea occurring to you, of substituting a metal disc for a membrane, and making the thing speak?—I would have had no difficulty in substituting a metal disc when I knew from the description that the metal membrane produced speech.

Were you aware, prior to that time, that metal in various forms had been used to operate as tongues for the receiving of musical notes?—Prior to 1876 I had given little attention to it. It was not till after the telephone had been discovered that I began to give attention to the subject.

Then you would not have been in a position to be a discoverer in 1876?—Not in 1876. My study of the telephone has been almost entirely subsequent to the inventions of Bell and Edison.

Therefore what your state of mind might have been prior to these inventions you cannot say.—I cannot say.

You told us that you are a professor in the Anderson University. What was your training before that.—I was a teacher of mathematics.

Not an electrician or engineer?—No. I also gave lectures on natural philosophy. That was in George Watson's College, Edinburgh.

You were not then even aware in 1876 that vibrating tongues had been used in connection with telephony?—I was not.

Did you become aware of that after the discovery of the remarkable properties of the metal tympanum held down all round?—I became aware not after that, because I knew of a vibrating tongue before I had seen a regular telephone.

A vibrating tongue that could only receive and reproduce musical notes?—Only musical notes. I never heard it reproduce articulate speech.

Is there anything you have seen in the prior publications founded on by the respondent—Sir William Thomson's address, the articles in the *Scientific American* and other papers, or any of them prior to 9th December, 1876—which indicates that the metal lid should be held down all round its circumference?—There is.

In speaking of the publications, to which of them do you refer: to any more than Sir William Thomson's address, and the article in *Engineering* of 22nd December, 1876?—To Sir William Thomson's address and Bell's experiments, as published in the *Journal of the Telegraph*.

And which of these do you refer to in speaking of the prior publications?—I mean Sir William Thomson's address.

And where do you find in that address any description of the receiver?—In it he said: "All this my own ears heard, spoken with, to me, unmistakable distinctness by the thin circular disc armature of just such another little electro-magnet as this which I hold in my hand. The words were shouted with a clear and loud voice by my colleague-judge, Professor Watson, at the far end of the telegraph wire, holding his mouth close to a stretched membrane, such as you see before you here, carrying a little piece of soft iron, which was thus made to perform in the neighbourhood of an electro-magnet in circuit, with the line motions proportional to the sonorific motions of the air." The only mention of the receiver is a thin circular disc armature, such as he held in his hand. As soon as such an instrument was set to work the disc would fall down, because if the tube were converted into an electro-magnet I would expect that its attraction would hold down the disc.

But by that, you say that on seeing the instrument at work you would then find something that you did not find indicated in the description?—Yes.

Is there any indication in the article of December 22nd, 1876, that the lid was to be held down?—I read, "Over this is fixed, attached by a screw, at a point near its circumference, a thin sheet iron armature of the thickness of a sheet of cartridge paper, and this, when under the influence of the transmitted currents, acts partly as a vibrator and partly as a resonator?

Is it not fixed at only one point? Is there the slightest indication of any fixture except by a screw at one point?—Only by a screw at one point.

Is not the description of the actual thing consistent with that metal plate acting as a free vibrator?—Yes.

And is not the drawing also consistent with its acting as a free vibrator?—Yes; only provided the tube does not become an electro-magnet.

Though you are not told so in the description, you would have assumed that it would hold down the lid?—Yes.

Then if you had been told, what you did not then know, that the lid would be held down; were you then aware that an iron plate held down at its circumference had the remarkable properties of reproducing articulate speech?—I was not aware.

And I suppose that Mr. Bell's invention was the first thing that informed you of that fact?—Yes.

And I suppose, Mr. Blyth, it was the first thing that informed the world?—I am not sure. It was the first thing that informed me.

In speaking of Edison's invention, you say it appears to you to relate exclusively to things that were easily compressible. Where do you find the words easily compressible or anything like them in the specification?—I gather it from the general description of them. He speaks of semi-elastic fibre and other substances, and I take it from these descriptions that it was an easily compressible substance. (Shown page 7 of the specification in which a description of the plumbago points is given.)

These may be hard points, Mr. Blyth?—Necessarily hard, if they are plumbago points.

But how do you read it—do you think that those two "compressed plumbago points, mixed preferably with gum rubber," will be hard or soft?—I believe they will be moderately soft; not very hard. I have never, however, seen compressed plumbago mixed in gum rubber, but I should think with a certain amount of pressure it would squeeze to a powder.

Then were you not rather sharp in assuming and saying that from his description Edison meant things easily compressible, and will you now dispense with the word easily, and content yourself with compressible?—They are easily compressible as compared with other substances—as compared, or instance, with carbon in other forms, as compared with gas carbon, for instance, gas carbon, plumbago and black lead are all forms of carbon; and they have all, but in different degree, the property of varying the resistance to the electric current according as they are affected by pressure.

And it is that property which is common to them which is material to this question—the variation of the resistance to the electric current?—It is not that property which is material, but perhaps I do not know what you mean.

You observe that Mr. Edison, rightly or wrongly, proposes to vary the resistance to the electric current by treating carbon in various forms. That is correct?—Yes.

Now in what you call the microphone, is the resistance to the electric current varied by the conditions under which carbon is placed?—The resistance to the electric current is varying slightly.

Is it not correct to say that in Edison's invention and in the microphone the resistance to the electric current is varied by the manner in which carbon is treated?—Yes.

You think that the thing that does vary is the pressure on the carbon?—Yes.

The compressions affecting the density of the carbon mass?—Yes.

Your view is that in the case of the microphone and of Theiler it is not the compression of the carbon that produces the variation of the resistance, but other causes?—Yes.

What is the other cause that might produce the variation in the resistance?—It may be the greater or less extent of surface contact.

Do you merely mean that you do not know what it is: May it be that, or may it be something else than a greater or less extent of surface contact?—I mean that it may be greater or less extent of surface contact that produces the variation of the resistance.

You say it may be that. But it may not be that, and if it is not that, what third thing may it be?—In the case of the microphone, a variation of the resistance may be produced by the actual transfer of particles of carbon from one to the other.

Have you any more possibilities to suggest?—No; I have matured no theory on the subject.

Then, supposing it is the extent of surface contact, don't you find that indicated by Edison in his specification where he says that in some cases he makes use of a variable resistance resulting from greater or less intimacy of surface contact such as would result from a disc covered with plumbago placed beside a tire also covered with plumbago? Don't you find there that he sometimes makes use of a surface contact; that all these possibilities are involved there?—It is not clear what he means. If I saw the instrument and saw it working, then I should be able to say whether it exhibited Edison's principle or that of the microphone. (Shown instrument.)

Is not that as described just carbon against carbon?—Yes, just.

Edison says: "So that the proximity or extent of surface contact will rise or fall by tension." Does not that plainly indicate that a result of the greater or less extent of surface amongst other things varies the resistance?—The extent of surface contact must vary the resistance.

We are unanimous about that; what I am asking you to consider is, Does not Mr. Edison there say that one of the modes by which he gets a variation of resistance is by presenting a larger or a smaller part of one carbon substance to the other?—Yes.

Why then, when a man tells you that, do you say that his sole principle is compression?—Because it is only by compression that he gets this variation.

Where do we find that?—I simply do not understand the point to which you are referring.

Lord Advocate: I will make you understand it.

Witness: If you make me understand it I will be able to answer.

Examination resumed.

Suppose we had the disc, and that it is covered with plumbago, and that it is placed adjacent to the end of a pencil, also covered with plumbago, we have then the conditions described in the specification?—Yes.

Suppose you put half of the pencil against the plumbago disc, that would be one extent of surface contact, and suppose we put the whole, that would give another extent of surface contact?—Yes.

Does not Edison tell you that he gets variations of resistance according as he presents a greater or less extent of surface contact between the two carbons?—Yes.

I have put that to you to show in absolutely the clearest way what might be under this. Now suppose that, instead of what I put to you, you have a pencil resting softly against the metal, and a diaphragm at the end, and suppose you speak at the diapragm, you would press the pencil against the disc: would not that create a greater extent of the surface contact of this one carbon against the other carbon?—It would.

And in precisely the same mode as you get the greater extent in the microphone?—Not precisely the same, as I understand it.

Well, tell me this: suppose the two are covered with carbon, and suppose you speak at the diaphragm against the end of the pencil and thereby get a larger extent of surface contact between the pencil covered with carbon and the disc covered with carbon, how do you get that greater extent of surface contact?—The two are not perfect mathematical plans, and you may get a series of points at one place and another set at another.

And is not that just the difference between what popularly you would call loose and close contact?—That is loose contact when it is pretty free.

Probably only the mountains of molecules touching when under no pressure, and more being brought into contact when squeezed?—Yes. It is true that when two particles are touching, that is contact; and it would be to call it closer contact if you squeeze the two volumes of which only the most prominent particles are in contact, and so bring more of the particles into contact.

And it would not be a very wrong expression to talk of that as "greater proximity of contact"?—I cannot understand that. You cannot have degrees of proximity.

I quite understand that in speaking of particles; but may you not have two masses of particles, which, when they are touching lightly, are touching only on some of their particles, but when put under slight pressure, touch on more of their particles ?—Yes.

Suppose that one of the two surfaces of the contact was a diaphragm partly covered with plumbago, the diaphragm into which you speak, would not a greater extent of surface contact in such a case as I put to you be produced by the vibrations of the diaphragm caused by speaking at it?—Yes.

The respondent's instrument—the Theiler instrument—has a mouthpiece and metal diaphragm into which you speak ?—Yes, and that is common to it and Edison. Behind the metal diaphragm there is cork both in Edison and Theiler, but not to the same extent, larger in one and smaller in the other. You come next to carbon, in the case of Theiler, the two vertical pencils.

When you speak into the mouthpiece, and against the diaphragm in the respondent's or Theiler's transmitter, do you cause the diaphragm to move at all ?—It cannot help moving.

And does it not result necessarily from that that it must also move the two vertical pencils lying against it ?—It cannot help doing that.

When the two vertical pencils are moved, I suppose their pressure against the lateral weighted cross pencil must be increased ?—Yes, necessarily so.

And there will be a pressure continuing until it is strong enough to overcome the inertia of the cross carbon and the brass weight ?—Yes.

They are in contact already; by the pressure the contact is made closer; the extent of surface contact is increased; and that will go on until the pressure is large enough to overcome the inertia and move the cross piece back ?—Yes.

What I have now described to you cannot help happening in the respondent's instrument ?—It does happen.

These things must happen—whether they happen in the microphone I do not care—they cannot help happening in the respondent's instrument ?—Yes.

When that happens, does the variation in the closeness of the extent of surface contact vary the resistance to the electric current ?—Yes.

Precisely the same thing which Edison says he does when he uses the two surface contacts of the kind he has described ?—That may be.

It must be ?—A variation of the resistance by the variable extent of surface contact will be produced in that way.

Is not what you say occurs in the respondent's apparatus precisely what Mr. Edison describes in his specification top of page six ?—I would not say precisely. I cannot understand that these two things are the same.

Is it not a variation in the resistance to the electric current resulting from greater or less intimacy of surface contact or greater proximity or extent of surface contact ?—Yes.

Now in your judgment is there any use of having a mouthpiece to the respondent's apparatus ?—Yes, the mouthpiece is of use.

Of what use is it ?—It depends upon the use you want to put the instrument to.

If we want to make it a speaking instrument ?—It is of use in that way.

As the human ear is of use—a man hears better who has an ear than one whose ear has been cut off ?—Yes.

BY THE COURT.—It acts in the way of collecting the sound.

CROSS-EXAMINATION RESUMED.

When Theiler's instrument is wanted to be a transmitter of sound is there any use of having a diaphragm in it?—Yes; something to support the carbon and receive the acoustic waves unless the acoustic waves are stopped by something else.

And the best kind of thing to receive these waves is something that will vibrate very sensibly in accord with them ?—Yes.

And there is nothing better for that than a metal disc ?—I would not say nothing better.

Is it not better to have cork inside the metal diaphragm for a speech-transmitting instrument ?—Not necessarily cork.

But you are the better for something of the kind?—Yes, you must have something.

Well, there are three things—the mouthpiece, the diaghragm, and the cork common to the respondent's instrument and Edison's, which all help towards transmitting speech ?—Yes.

Now would the respondent's (Theiler) make an equally good transmitter if it had none of these—if it were simply three pencils locked into a closed box ?—Not quite

And it would be something specifically different ?—Not specifically different.

If it were merely three pencils locked into a box these pencils could not be acted upon as with the diaphragm ?—The whole box depends on the diaphragm in that view of it.

Quite true, but the whole of the box would be vibrating if you had no diaphragm mouthpiece, and cork instead of the diaphragm ?—Yes.

You have not the least doubt that for a speech transmitter the arrangements common to Edison and Theiler have great advantages—mouthpiece, cork, and diaphragm?—No doubt.

Now when you speak of the compression of carbon in the mass is that anything more than compression brings a larger number of molecules into contact *inter se* ?—I know so little of molecules I cannot say.

You have no notion. You do not know whether it would be the same kind of action as if you had two waves of carbon brought into contact and squeezed ?—It may be the same, but I have no notion.

You told us, I think, that you tried an experiment as to the effect of compression in varying the condition of hard carbon for resisting the electric current—would that be properly indicated by squeezing the ends of the pencils, which had electrical waves, tight somewhat down its length ?—Yes.

And would you mean us to squeeze these ends ?—Yes.

Your squeezing was not at the point of contract, not where one wire touches the other ?—No.

You understand the meaning of the point of contact in this discussion. It means where the two conductors touch, that is, the wire that touches the pencil or carbon, and where they touch—that is the point of contact. But your experiment did not involve the squeezing in the circuit ?—No.

You did not try whether by squeezing it would have altered the carbon power of transmitting ?—I believe the resistance would alter.

And are not all the pressures Edison in his patent refers to pressures which come directly or indirectly on the point of contact ?—Pressures through the point of contact.

Then the kind of pressure you tried was a totally different kind of pressure ?—Precisely.

But when you did try pressure at the points of contact of the conductors you did find a resistance there ?—Yes.

When you used a pressure similar to Edison's pressure, you got the result—variation to resistance ?—Yes.

And that is what Edison gets ?—Yes.

You did not undertake to say whether it is pressure throughout the mass, or pressure at the points of contact, or both, that produces the result ?—It may be both; limiting it to carbon, the effect of pressure throughout the mass to make variation to resistance. That would be so also at the points of contact. Edison's, as I understand, is a changing specific mass.

THE COURT: In the actual experiments you made was there anything to show the variations of pressure going on throughout the mass of the carbon ?—No.

CROSS-EXAMINATION RESUMED.

It may be but slight ?—In my first experiment I found no variation to the resistance due to pressing the carbon.

Because you were not holding it tight all round, it might pass to the sides ?—Possibly.

A hard substance would show less prominently a change of that kind than a soft one? It would be more difficult to compress the particles of a hard substance than a soft one ?—I believe it would.

And that would account for it ?—It might depend entirely upon the kind of carbon, but I cannot say whether it does. I am not a chemist.

I need not trouble you, Mr. Blyth, very much about sympathetic vibration, because in the Theiler you say it is a push and pull vibration ?—I did not assert that that was all, there is a certain push and pull.

It may be all ?—It cannot be all.

Because the box is vibrating round it ?—Yes.

And I suppose the same may be true of any transmitter that is more or less in a state of tremor ?—Yes.

And therefore what you say would be more or less true of Bell's and Edison's, and them all ?—Yes. There are air pulses all round, and there would be a tremor in anything that caught and stopped the sound. It may therefore be common to all forms of transmitter in varying degrees. I do not think the phonograph is disclosed in the provisional specification.

Do you see in that specification the words "portions of the apparatus are interchangeably available in transmitting and recording, others for local things, some only available in transmitting and others only for receiving ?"—I see that.

Is there any portion of the apparatus described in the final specification that is interchangeably transmitting or recording ?—I think not.

Is the phonograph interchangeably available in transmitting and recording sounds ?—I understand how the phonograph records sounds, and I see methods whereby it may be used for transmitting sounds. The phonograph, when you speak to it, records along the tinfoil substance by a needle, and by making the needle travel backwards along the same track, the needle communicates the vibrations to the diaphragm, sending the diaphragm into motion, and making it speak.

Would there be anything to prevent the diaphragm of the phonograph, which is thus made to speak, speak to the transmitter so as to send on the message again—any transmitter you like ?—Well, you may say it transmits.

You can hear the diaphragm on the phonograph speaking; is there anything to prevent that speaking diaphragm from being so placed in connection with the transmitter that it will send on what it speaks ?—There is nothing impossible in it, I think.

Does not that show you that the phonograph would answer this description—"a portion of the apparatus interchangeably available in transmitting and recording." It would be available for recording when it took down the message, and available for transmitting when it gave out the message to the transmitter by which it was to be sent out ?—Yes.

Then would not the phonograph be interchangeably available ?—My view of the phonograph is that you employ it as a transmitter at the one end and a receiver at the other.

Well, you have taken a wrong impression, but if the phonograph might be used in the sense which I have explained, it would be interchangeably available for transmitting and recording ?—Yes.

Is not that making it change its use—you make it first act like a shorthand writer, and then like a speaker ?—Yes.

Well, is not that interchangeably available as recorder and transmitter ?—I do not understand you.

If you make it speak to the transmitter, and the transmitter transmits its message, then the phonograph has been employed as transmitter, and that would be making it interchangeably available ?—In that sense it would.

And you cannot find out any other piece of apparatus that will do hese things except the phonograph ?—No.

Re-examined by Mr. Salvesen.

The phonograph will only transmit what you make it speak into the transmitter ?—Yes.

And you require a transmitter apart from the phonograph in order to transmit the sounds of the phonograph ?—Yes. I think greater or less extent of surface contact may have something to do with the action of the microphone, but I do not think that it explains the action of the microphone, and I say there are disturbing influences that prevent that from explaining its action. The action would depend upon how the disc was covered with plumbago, in what manner, and to what extent.

If with a thick coating, and placed in close contact, how would it act ?—Only by varying the resistance under changes of pressure.

I suppose it is correct to say that assuming that you have two perfectly unelastic substances in contact, you will not get a greater number of parts of contact when more strongly pressed, and that the more elastic they are the greater will be the variation ?—Yes.

Now with reference to the diaphgram, what kind of vibrations do you think are those which chiefly account for the action of the final transmitter—is it of the forced sympathetic vibrations, or the push and pull vibrations ?—They are the sympathetic, and Edison's are the push and pull. I have no fixed theory as to the action of the microphone, but it is not accounted for simply by variations of resistance. There are a series of phenomena, all of which combined might account for its action. I think the exquisite make and break is as probable a thing as any to account for it.

Re-cross-examined by the Lord Advocate.

I am aware that it was by the make and break that the musical tones are transmitted and that it was by the undulatory method that the voice was transmitted.

Are you aware that it was from the incapacity of the make and break to transmit the variations of the voice that all instruments prior to Bell were incompetent to speak ?—It was not in consequence of the make and break, but in consequence of the indelicacy of the make and break.

This concluded the evidence, and the Court adjourned for lunch.

On reassembling Lord M'Laren said he presumed it was not disputed that the address of Sir Wm. Thomson and the publicity given by the article in *Engineering* had made public a very important part of Mr. Bell's discovery, namely, that sound could be transmitted through a closed circuit which gave a more delicate and accurate movement than the open one.

Lord Advocate said he hardly thought that what was stated even went that length.

Lord M'Laren: At all events it had been seen in operation in America. In that case it was competent to any experimenter to endeavour to make the idea work, and it was part of the common stock of knowledge that there must be a transmitter and receiver in order to produce in some form a musical instrument; and the question is whether the subsequent disclosures would effect such improvements on the apparatus as would amount to an invention. And with regard to the Edison patent, it strikes me the difficulty of the case lies here—that there is common to all forms described in Edison's patent, and also to the microphone, and to the form used by the respondent—there is this in common to them all—that instead of the closed circuit, in the ordinary sense, you have what is said to be a closed circuit, but with one of the points of it closed by the contact of two surfaces, not mechanically united, but held in contact under slight pressure, pressure sufficient to allow of a certain vibration or reaction between the surfaces. Now, the question is whether the specification makes it clear that that was a discovery so that every one would know that any process involving vibratory contact between two surfaces, with mere slight variations, would fall within this patent, or whether it is an erroneous idea that if the action took place through compression of the material it might be thought, material apart, to stand, so that others bringing in contact slightly compressible substances might conclude that they were not infringing the patent.

Lord Advocate: I think the question is entirely limited to that, and I hope to be able to satisfy your lordship to that extent, and also as regards Bell's. The one question that remains is very much as your lordship has put it, and I think, therefore, that the case, so far as argument is concerned, may be stated comparatively briefly.

The Lord Advocate said: Your lordship will probably have noticed that there are two things set out in a patent of this nature and which it is alleged the respondents have infringed. These two patents may shortly be described as the Morgan-Brown patent, patented in this country; Bell's invention, a communication from abroad, and Edison's patent, also a communication from abroad, but patented in Edison's name in this country. Now we complain that both these patents have been infringed, and I think I can state very shortly to your lordship that our position upon the two patents is this—that we maintain that the Bell receiver and the Edison transmitter respectively have been infringed. The complex instrument which we used and which has proved to be of such enormous commercial value, probably a value which will daily increase, for I fancy we are only at the beginning of the appreciation of the merits of the invention, consists of a combination of the two inventions specified in these two patents, and as we set out so long as these two patents were in different hands, it was not possible for any one to have the best instrument. These patentees, however, sensibly combined their inventions into the United Telephone Company, which your lordship has now before you as the complaining company, and thereby each bringing into the copartnery a very valuable contribution, the one bringing the best receiver, and the other the best transmitter, they two have, as we submit, the best telephone ever discovered. And so what they complain of is that the present respondent, Mr. Maclean, telegraphic and telephonic engineer, Edinburgh, has practically taken the entire invention, or rather the pair of inventions, of which ours consists—the Bell receiver and the Edison transmitter. So that, my lord, it is necessary to enter, as I hope to do very shortly, into some, however slight, criticism of these two patents. As regards the Bell patent, I think it will be possible for me to limit my observations to one point only, that point being whether the Bell patent is void in respect of the invention, particularly of the invention relative to the receiver being disclosed before the patent was taken out, disclosed by Sir William Thomson at the meeting of the British Association in Glasgow. The reason I say that this is the only question is this—that my learned friends have not sought to assail the Bell patent on any of those technical grounds we are familiar with, such as were made on Edison. But I think there was no complaint made against the Bell patent in respect of its technical or formal sufficiency whatever, and I think I may now take it that although we had notice, partly by record and partly by a subsequent minute, of a large number of prior inventions and publications, it is not now maintained that any of these claimed the invention which may be shortly described as Bell's receiver, unless Sir William Thomson did in 1876. Now, on the question of infringement of the Bell patent by the receiver used by Mr. Maclean, I think Mr. Mackintosh has relieved us from the necessity of entering upon any discussion of that also, because, while he quite properly and legitimately says I am not admitting in words that Mr. Maclean infringes Bell in regard to the receiver, I only mean to object to the word "infringe," that it pre-supposes and infringes a valid patent, and I deny that that is a valid patent, it having been anticipated by Sir William Thomson at Glasgow. Briefly, then, I may say that the only point in controversy between us respecting the respondent's receiver and the Bell patent is this—Was the Bell void because before the 9th December, 1876, the receiver thereby patented had been disclosed to the world? That is one question, then, and I think upon it I shall deal very shortly with it upon the evidence submitted. And, perhaps, before referring to that evidence, I may just recall your lordship's attention to the general principle or rule which applies in such cases, that is to say, to point out what is essential in the case of a prior publication, because unless one has a notion upon that it is not very easy usefully to consider the evidence bearing upon the alleged disclosure. I think it cannot be doubted that any disclosure to void the patent must contain as full and as distinct and useful information with respect to what the invention is and the mode of carrying it out as does the patent itself. It is not enough for somebody to say that there was a machine shown which was the machine afterwards patented, if that apparatus needed any explanation or anything to enable it to become useful, in short, it must be something which conveys not only to persons of the highest skill, not only to persons of unique skill—as I think it will be proved in this case is the only pretence conveyed to any one—but it must be such as in the ordinary language of the patent law will enable a workman of ordinary skill in the department of work to which the invention relates to construct that apparatus. I will only refer to one or two passages, because it is really elementary now. I think that that is essential. In Hills *v.* Evans, No. XXXI. *Law Journal*, Chancery 463, the law is stated very clearly. In giving judgment in this case, Lord Chancellor Westbury said, "the antecedent statement must (in order to invalidate a subsequent patent) be such that a person of ordinary knowledge of the subject would at once perceive, understand, and be able practically to apply the discovery without the necessity of making further experiments and gaining further information before the invention can be made useful.......The information as to the alleged invention given by the prior publication must, for the purposes of practical utility be equal to that given by the subsequent patent. The invention must be shown to have been before made known. Whatever, therefore, is essential to the invention must be read out of the prior publication. If specific details are necessary for practical working and real utility of the alleged invention they must be found substantially in the prior publication. Apparent generality, or a proposition not true to its full extent, will not prejudice a subsequent statement which is limited, accurate, and gives a specific rule of practical application. The reason is manifest, because much further information and therefore much further discovery are required before the real truth can be extricated and embodied in a form to serve the uses of mankind. It is the difference between the ore and the refined and pure metal which is extracted from it." That is a highly authoritative statement of the law given by a judge of the greatest eminence not in law generally, but especially in this department of law. The same thing is also very clearly stated in some of the other cases. There is the very well-known case of Betts *v.* Menzies (ultimate reference X. House of Lords' Cases), and in that case Lord Chancellor Westbury says that to void a new patent it must be clear that "the antecedent specification discloses a practicable mode of producing the result which is the effect of the subsequent discovery," and Lord Colonsay, sitting in the House of Lords (L. R. 5, H. L. 2,) says, "It is not enough that there has been in a former patent a general disclosure of the object to be attained, unless there is a specification clearly pointing out the mode of attaining it." If that is true in a patent it would be still more true in a publication, which is not a patent. Now one of the latest cases in which this has been gone into was that of the roller skating cases, Plimpton *v.* Malcolmson (III. Law Reports Chancery Division, page 531). Amongst the numerous questions which arose in that case was the point of prior publication and on it the Master of the Rolls, Sir George Jessel, said: The second point is this: Assuming that the book was publicly known, or at least so far publicly known as to be known to all interested in these matters, the defendant alleges, and the plaintiff denies that the letterpress and drawing together do contain that sufficient description which is necessary to enable a workman of ordinary skill to make the patented machine. As to that again, one must consider what the law is. First of all, what is required as regards prior description? I should have thought, independently of authority, that no prior description ought to invalidate a patent unless you could make the thing from the description. I mean unless a person of ordinary skill in the trade could make it from the description. But it has been alleged that something less will do. As I read the authorities that is not so." The actual words used there by Sir George Jessel have relation exclusively to a roller skate which is a mere structure not requiring any knowledge of the mode of working except so far as skating is the mode of working, but not requiring the introduction of any other scientific matter, such as electricity.

His Lordship: In chemical discoveries a person attempting to copy may be entirely put out by the motion of some apparently trifling thing which he could not discover through any previous description.

Lord Advocate: And that is what I think will be found to be the absolutely conclusive point in this case, namely, that there was a new law, which men of the highest skill did not know until Bell discovered and disclosed it. It is further to be kept in view that mere experimental use of a patent will not invalidate it. After reference to an opinion upon this point by Mr. Justice Cresswell the Lord Advocate proceeded: The law, I think therefore, is quite clear that in a question like this where you have not only to deal with a piece of mechanism to be used in treating and handling some of the most occult properties (I believe it is even doubted whether electricity is a thing in the sense even of being a fluid, or whether it is simply a mode of action, but nobody knows), it is not enough to put upon the table an apparatus unless you show how that apparatus can be used so as to be acted upon in the way requisite for the requisite result. The evidence on that point stands thus: Sir Wm. Thomson was at the Centennial Exhibition at Philadelphia in June or July, 1876. Bell had at that time made a great many inventions in telegraphy and telephony, and he was showing these very good naturedly to his friends. He showed them as perfected inventions for which he had before taken out patents. When he had shown these, he then, according to Sir Wm. Thomson, made some announcement of this kind: Now, I will show you something very much more wonderful, something by which articulate speech can be transmitted and reproduced. That was a thing absolutely novel at that time, because, although it had been possible to transmit musical notes prior to that time, every one had failed to transmit and reproduce vocal spoken words, because these words involved such various articulations and such various minute, and almost imperceptible changes in the air pulsations that all known methods had failed to take up and communicate these to the other end of the wire. I am not leaving out of view in that this—that some people had got vowel sounds, or something approximate to vowel sounds, and possible almost words in that way had been successfully sent through previously known methods; but your lordship will see that that does not take from the generality of the proposition I am laying down, because when you come to it you are practically speaking but one note or one tone; it may be "a" or it may be "o," or any other vowels, so that it is just a musical note, and that possibly can be transmitted. But it is quite a different thing where you can transmit, and it is common ground up to that time you could not transmit ordinary speech. The reason of that is highly material to this inquiry. It was this, that according to all the methods known prior to Bell there was a make and break; there was not a continuous current—or a current so closely approximate to continuous that it could do the requisite thing, although there was not either actually a continuous current, and this is also as important with regard to another portion of the case—although the current and the sequence of the pulsations were so speedy that they could produce words in the manner of the Morse telegraph so quickly, but still it was a make and break. For the reason given, that was incompetent to transmit articulate speech. But Bell conceived the idea of producing undulations in the current which remained a constant current—it was what is called a closed current—it was a constant current in respect that it was not broken. I do not think it necessary to go back upon the different modes of generating the current, but his great idea was that it was for the first time a method of transmitting waves along the unbroken current of electricity, like making waves in a canal of water which rippled onwards without a break in their continuity Sir Frederick Bramwell illustrated the difference by using the illustration of shutting off the water in the one case. Well, the part of the invention we are concerned with here was a receiver. According to Sir William Thomson Bell himself said that that was a mere experimental thing—the thing he was working at. He said he would now show us something which he could scarcely call an invention which was in embryo, but what might become an invention, the object of which was to reproduce articulate speech. Mr. Bell said he thought he could let us hear some differences of sound corresponding to the differences of different vowel sounds. They tried it, and got the words, and he heard "to be or not to be," and "there's the rub," "but I could not have sworn that 'the rub' was there if I had not known it was coming. I heard 'the rub,' and it was very distinct." That was after a great deal of delicate adjustment, when six cells had been tried and found too much, then five cells tried, and so on. Sir William said that he felt afterwards that he had been carried away by his enthusiasm, and that he urged Bell to persevere. That will recall to your lordship's recollection that according to Sir William Thomson it was not complete even in the knowledge of Bell at that time, and it is an important fact to keep in view that Bell did not patent it at all till 1877, and no human being published it, for the reason that no human being knew of it at this time. That was all Sir William Thomson knew himself, and Bell, when he was going away, very courteously, as a friend, gave him away the membrane transmitter and the receiver. Such a gift fell under the principle of Thornton's case, that a gift was not publication; but I do not care to go into that, because I do not for a moment suggest that Sir William Thomson did anything he should not have done in doing what he did at the British Association meeting.

His Lordship: It was patented in America by that time.

Lord Advocate: Not at that time, not till 1877 was the metallic diaphragm patented.

His Lordship: If Sir William Thomson had known he was taking out a patent he might not have said anything about it at the British Association meeting.

Lord Advocate: Probably. I am only referring now to what passed in America for the purpose to show that if Sir William Thomson, when he saw and heard, did not understand this receiver at all, and it never once entered into his mind how that receiver could be got, least of all did he ever think that its power of speaking was due—and it is very doubtful if any power to speak is due—to the tympan or diaphragm being in contact all round. Sir William had not an idea of that. Bell had not an idea of that, and Sir William Thomson says that so far as he can recollect when he heard that speak in America it was not kept close down. You had to keep your ear near it, but he said that when it was pressed down it seemed to kill the sound. Therefore I think Mr. Conrad Cooke must be mistaken in what he said, and it is quite plain that Sir William Thomson could not have said it, because he had not the knowledge to say it. This is just an illustration of what we are quite familiar with, that men looking back upon the past in the light of subsequent acquired knowledge, mix up what they have since learned with what they knew before, and I say without the slightest fear of contradiction, that Mr. Cooke is mistaken in this matter, because his evidence will not stand against that of Sir William Thomson, and Sir William has told us that he could not say so himself because he had not the knowledge himself. He certainly does not inform Mr. Cooke.

Mr. Mackintosh: He does, and the subject was canvassed.

Lord Advocate: After Sir Wm. Thomson's experience, as he told it to us in the witness-box, that when they kept it down they killed the sound he would then have been telling Mr. Conrad Cooke, not how to make it speak, but how to make it keep silent. I am at a loss to know how he told anybody, because he in his own statement said he did not know how to, and he never could, make it speak even in his laboratory, that it has never uttered a word (I think my learned friends are going to try and make the thing vocal), but that it has preserved the golden silence which it seems to have kept up from the first, and now that is positively what is described here as a disclosure of that great invention, admitted to be a marvellous invention. Now it must he noticed that not only Sir Wm. Thomson never heard that thing speak, but that he was ignorant of the great natural law upon which it did speak. Mr. Conrad Cooke, was ignorant of it, so was Mr. Blyth, because he only began his telephonic studies in 1876, and all the knowledge he has acquired has been acquired since Mr. Bell's great discoveries were published, and all the others, Thomson, Fleeming Jenkin and the rest, were all ignorant of that law. No man had penetrated that box, and until Bell had made the discovery there was not a single man who knew the law that a metal plate would reproduce speech when fixed in that way. In his evidence Sir Wm. Thomson says, "I could not have explained that when the machine was working the lid was down. When I exhibited it at the British Association I did not explain that when working the lid was kept down." From this I think your lordship will see that he could not possibly have said to Mr. Cooke, "If the ear was pressed too hard, so as to bring the plate into contact, the sound seemed to begin." You see from that that the ear there is merely spoken of as the medium of bringing the thing down, so that Sir Wm. Thomson has twice said that when the plate was fast down the sound in one case was killed, in the other case it was checked, and it was therefore impossible that he could say to Mr. Cooke what Mr. Cooke now says he did; what is more material is that Mr. Cooke did not say that to anybody else. All he said was that Sir William had said that he with his own ears had heard words spoken with unmistakeable distinctness by the thin circular disc armature. I do not know whether my friend relies on any of the other prior publications. He will tell you that you will find in one of 1st August, 1876, mention made in an article in the *Journal of Telegraphy* of two single pole electrical magnets, one of which was kept in the experimental room, and the other in the basement of an adjoining house, and that the sounds of the voice were reproduced by the instrument in the distant room. But that was a case with a membrane at each end, a telephone with a membrane at each end, not a metal one. So in the *Scientific American* of 9th September, 1876, you there again have a membrane. And then you come to what was not prior, but subsequent—to the article in *Engineering*. Mr. Conrad Cooke had still no more idea of what was in that. All he said about it was in describing the structure, "over this is fixed, attached by a screw at a point near its circumference, a thin sheet-iron armature, of the thickness of a sheet of cartridge-paper, and this when under the influence of the transmitted currents, acts partly as a vibrator, and partly as a resonator." He did not say, because he did not know, that you should keep that down. If he had known it he would have said it. The reason he did not say it was that he did not know it, and if your lordship desires to know what he means by "vibrator" in that you will see very easily, because he uses the word "vibrator" five or six times in referring to Reiss and Gray, where he mentions that the apparatus includes a vibrating reed, and a vibrator at the receiving end, &c. I have no doubt that no one person thinks in the state of knowledge at that time that what Mr. Cooke meant, when he spoke of the vibrator in describing the instrument shown by Sir William Thomson, was that it was applied, meant exactly in the same way as this apparatus of Mr. Bell is applied. I submit it is not, and without going further into that matter, I maintain that there has been no prior publication here, and consequently that as that is the only ground upon which Bell's patent is attempted now to be assailed, that fails, as it very well deserves to fail, because it is undoubtedly an attempt—looking back upon the state of ignorance of this instrument then prevailing—on the part of two gentlemen of infinitely less knowledge and skill than those examined for the complainers, who state that if anything had been known about the matter they would have known it. So that Mr. Blyth is able to say, if I had known anything about telephony in 1876 this would have taught me about Bell's invention. It is not often the court is asked to give such a finding as this.

HIS LORDSHIP: I do not think we have evidence that the moveable lid, held down by a magnetic force, is capable of transmitting distinct articulate sounds. It has not been so shown.

LORD ADVOCATE: I think that is not questioned. There is no question as to the utility of the invention, but it is really no great matter now to show what Mr. Cooke said about that. Mr. Cooke was so profoundly ignorant of the apparatus that he gave evidence to the effect that there was an interruption in its power of transmitting electricity, and that was wrong. He brought a galvanometer, which was only capable of indicating very great currents, and found that the other instrument was so slight that it was fitted to transmit electricity, though it would not affect his galvanometer. He was so profoundly ignorant of that apparatus that he explained its silence and apparent uselessness by its break in the current. The magnetic attraction was so weak that it would not pull it down when it was acting as a tuning fork or reed, which was the only condition in which Mr. Conrad Cooke ever saw it before. But when it was unscrewed, then there was magnetism sufficient to keep down the lid. I ask if testimony such as this really can be taken to show that there was this disclosure, as against statements by Sir William Thomson and Fleeming Jenkin. He said, "I got the articulation, but not very distinct." But the question was—whether there was anything in the state of electrical knowledge at that time which either did or would make this articulate speech. The evidence is all against this, and therefore the allegation that this was a Bell receiver cannot be entertained for a moment. I shall dwell now shortly upon the Edison telephone, as in the Edison patent. Upon that, I think the only point made against the validity of the original specification—and there again, as in the case of Bell, it becomes material to inquire whether the patent is to be voided before we know whether it has been infringed—is that, while it claims the phonograph, it is said that no phonograph was in the mind of the inventor when he applied for the provisional specification. That question of provisional specification we have not heard much about of late, for there have been no cases for many years in which a patent has been held to be bad on that account. The law, I think, has been clearly and well-settled thus: A provisional specification does not require to specify the invention; it only requires in a reasonable sense to identify the invention. The very object of allowing six months between the provisional and the final specifications is to allow the inventor to perfect it; but lest he should perpetrate a fraud upon the Crown, and lest he should get a patent for something else than he contemplated in the original specification, or make a new invention and cover that with his first specification, the law requires that he shall in general terms state what his invention is, but does not require details. On that matter I can give one or two references which will, I think, sustain my proposition. In Newall *v.* Elliott (Higgins' Patent Digest, pages 162 and following), Chief Baron Pollock says: "The object of the statute, which requires a provisional specification, is nothing more than a legislative recognition of the custom which called upon every patentee, when he applies for the patent, to give some notion of what his invention is. That has been followed up by an Act of Parliament requiring it to be done; but the object in both cases is to ascertain the identity of the invention, and to make it certain that the patentee shall ultimately obtain his patent for that invention which he presented to the Attorney General in the first instance." Your lordship will find the same thing laid down in Penn *v.* Bibby, (Higgins, page 360):—"The filing of the provisional specification, by the express provisions of the statute, protects the invention for six months, and gives the patentee during this period, the like powers, rights, and privileges, as might have been conferred upon him by letters patent. The object of this protection evidently is to enable the patentee to perfect his invention by experiments, which although open and known, will not be a user and publication to the prejudice of letters patent to be afterwards granted so that he may be in a condition to describe in his complete specification, as the result of his experience, the best manner of performing the invention." So that it is quite plain that it is enough if the information which the inventor has given shall be such as that he will not be able to perpetrate a fraud on law officers, and if it is covered by the provisional specification it is covered by the other. The only case which I am aware of, when the patent has been held back upon the ground of disconformity, was one we had in this court. It went to the House of Lords ultimately, and I think it is the only case for 20 or 30 years which failed on this ground. It is the case of Bailey *v.* Robertson, which is reported in 3 Law Reports, House of Lords' Appeal Cases. But in that case the difference was enormous. The patent was for a certain combination for preserving meat; and in the provisional statement the description of the invention was for using a solution of gelatine and bisulphate of lime, while in the final specification there was a claim made for bisulphate of lime without the gelatine, an enormous difference. The House of Lords said. "You were allowed to get your patent for a combination of the two, and if you had applied for a patent for bisulphate of lime alone, it would have been two wide, and what you have done is to claim a wider thing in your patent than in your specification, and therefore your patent shall not stand." The latest opinion is that of Lord Blackburn in the same case (3 Law Reports, House of Lords' Appeal Cases, p. 1074). So that your lordship sees that what requires to be done is to state the nature of the invention, or give a notion of the invention, but minute description is not required. Very well, the claim is said not to have been known at the time of the provisional specification, and not to have been hinted at. As for the phonograph, is the method of transmitting and recording sound by such material acting upon a diaphragm? Well, your lordship has already had the evidence of four gentlemen for the pursuers, all of whom say we have not the least difficulty in recognising in that passage at the top of page two the phonograph and nothing else, and this is really the matter for your lordship—if it be, in the light given by the scientific evidence, possible to say that there is anything else that it can be but the phonograph. We have had it in evidence that the phonograph not only records, but reproduces, and that that power has been used usefully and advantageously in the transmission of messages. The phonograph simply is, that when you speak to the diaphragm there is a revolving roller travelling along, and a track is made on its surface; and if you turn it back the other way, the diaphragm will speak, travelling over the same track, recording and reproducing. It was admitted, both by Mr. Cooke and Mr. Blyth, that it might. Mr. Johnson says it does, and that you can do that at intervals in a telephonic line, and that if you have any doubt whether you have gone far enough to make the impulses strong, you can write it down on your phonograph, and at any stage give it a fresh start with fresh battery power, and send it on to the next stage. Is not this making portions of apparatus interchangeably available for transmitting and recording? Now, while Mr. Cook said that he had not seen indications in the provisional specification of the phonograph, his evidence was—taking what I might take the liberty of saying—an unprecedented liberty with the specification, because he says that the specification is so full of mistakes that he reads in it the word "receiving" instead of "recording." Therefore, don't think your lordship will have much difficulty in reading the patent as it stands, and holding that recording is recording, and not that it is something else. Well, Mr. Conrad Cook admitted when it was put to him—and he could not help admitting—that the phonograph could be used for transmitting and recording. What more do you want? You find one of the three claims which on the admission of our opponent's evidence answers the description of an apparatus interchangeably available for transmitting or recording. No other apparatus does that. Does not that describe the relation, the identity of the invention and the nature of the invention? The object of requiring this provisional specification is to prevent the possibility of a fraud upon the Government and law afterwards. Could any man have given that specification who had not the telephone in his mind? I submit no one could. In the provisional specification an apparatus is set forth specifying that it is interchangeably available for transmitting and recording, and that the phonograph does. I shall not, therefore, be afraid that your lordship will be in the least likely to void this most valuable patent by saying that it claims something which is not in the provisional specification, when the evidence is unanimous that it is.

HIS LORDSHIP pointed out that there were some portions which could be made available for taking record of the atmospheric sound waves or electric sound waves.

LORD ADVOCATE, continuing, said: Your lordship will see that it is necessary to specify it so as to carry it out in detail. It is merely to give a notion of it. In page 6 you will find what is nothing at all except the amplification of that, and thereafter he (Edison) proceeds to describe the rest—the recording and reproduction of the sound. Is not that the same thing that he shadowed out generally in his provisional specification? I venture to spare your lordship any more observations on that point. Again, on page 6, there are these words—"If these sounds reproduced from the phonograph are to be transmitted over a telegraph line, the diaphragm, 10 C, figure 6, is provided with a cork diaphragm, &c.," so that you have got herein described, recording, reproduction, and transmission, and admittedly the phonograph will do all this, while nothing else described in the complete specification will do it. Now, admittedly the most important point in the case is whether, assuming as I shall now assume, Edison's to be a valid patent, it is infringed. There is nothing said against its validity except on this one point of the specification. On the question of infringement I need not say that it is very seldom that the infringement is so unblushing as is that of the Bell receiver here, that is, so unblushing that it is no longer denied. There is a greater pifference between the infringing transmitter and the patented one—a greater variation in appearance; but I shall venture to maintain to your lordship that there is not a greater variation in substance. As regards the law on that matter, I don't think it necessary to read anything upon it. There may be the greatest possible differences in appearance—so many that you might not recognise the one from the other under the law of colourable variations. In Bovill *v.* Moore it is said, regarding varying the form, that "a person who uses the same means in substance as a patentee of a machine, though the form of the machine be different, commits an infringement; and Chief Justice Gibbs said he remembered that that was the expedient used by a man in Cornwall who endeavoured to pirate the steam-engine. He produced an engine which on the first view of it had not the least resemblance to Boulton and Watt's: where you looked for the head you found the feet, and where you looked for the feet you found the head; but it turned out that he had taken the principle of Boulton and Watt's engine." I need not say that even a variation, an improvement that adopts what is substantially the invention, will be an infringement. Now, my lord, the way in which it is attempted to be said that this is not an infringement is this. It is said by the only two witnesses examined for the respondent here that Edison's invention is limited to the use of such substances as tension regulators as vary the resistance by creating a variation of the density of the material of which they consist. That is their first proposition. Then they travel away to the mechanism of which we know nothing here, and of which we could know nothing—Hughes' microphone. I don't know that your lordship has seen it. Well, they travel away to Hughes' microphone with which we have nothing to do. It is said Hughes' microphone is different from Edison's telephone, and the third step in their reasoning is that Theiler's transmitter is Hughes' microphone, and because Theiler's transmitter is the same as Hughes' microphone *sequitur* respondent's is different from Edison's. This, my lord, is simply for the purpose of introducing confusion. I submit that the then implement, which is not now here in any competent form, is introduced to break the circuit, as I may say, of the connection between Edison and Theiler, its resisting power being so great as to stop the current between Theiler and Edison altogether. Anything that is said about Theiler is said about Hughes. Now, there is something not to be left out of view in looking at the two instances. We see that Edison is the only claim we have now to deal with, claims in the instrument for transmitting influences by sound, a combination of diaphragm and tympan—a combination whether of diaphragm or tympan, of electric tension regulators "substantially" for varying the resistance in a close circuit—not precisely but substantially, as set forth. I may say, your lordship, that that is not the invariable form of drawing claims, because sometimes it would be a dangerous form. When a man wants to claim a precise mechanism, and no other, he claims it, and has no other interest in the invention. The danger of it is that it may be too wide, and consequently when you wish to claim a precise instrument you claim it. That is what is done when you claim the Bell combination. But when you claim arrangements of parts, made substantially as set forth and operating substantially as set forth, that does not confine you either to the precise arrangement, or to the precise mode of operation; it gives a latitude.

Lord M‘Laren: It is a proper form of claim for what an inventor knows to be a discovery, but it may be varied in other ways, according to modifications.

Lord Adovocate: What is the obligation of the inventor in that matter? It is simply, that instead of claiming the invention in general terms, to give instances of the way he carries it out. There is no obligation on the patentee to exhaust all the instances. He does enough if he gives some, or, as far as he knows, the best instance. I quite admit that if he has a better, and knows it, he must not keep it back; but if he deals fairly with the public, and gives these modifications—good ones—as far as he knows the best, he fulfils his obligations. And that implies that he does not confine himself to particular ways, but has a certain latitude, and, of course, claims a certain protection for things not specified. Now, going through that claim, what have we in common between the two? There are three things in the claim—electric influences by sound; a combination of the tympan or diaphram with the tension regulators and those working with a closed circuit; so that you have really these three things. How many of them have you here? You have a diaphragm or a tympan; you happen to have a cork behind which Edison sometimes has and sometimes not; you have here close circuit; it happens you have got primary and secondary results, so that you have the three things—the diaphragm or tympan, the tension regulators, and these working with a closed circuit. You certainly have got the first and the third; you have got the diaphragm or tympan and the closed circuit. Have you got the middle term—the tension regulators? Well, you have got something very like that. What we have to determine is not whether it is possible to make microphone transmit, which may be outside my patent. It may be possible, but I know it will be practically useless. Therefore, it is nothing to the purpose to say that if you simply hang by the box, that if he will dispense with the diaphragm he will, perhaps, keep outside my patent. But he cannot, because he knows they are essential to the successful working of his telephone. But, as I say, we are not here to prejudge whether there may be equivalents for the diaphragm. We have here the case of an instrument being used which begins with a mouthpiece, proceeds to a diaphragm, which has behind that a cork, and behind that a carbon. Now, without going into detail on the evidence of the complainers' witnesses, your lordship will recollect——

Lord M‘Laren: I suppose if they dispensed with the diaphragm they would be without the patent, because the tension of the diaphragm is the material point?

Lord Advocate: Yes. But I would ask your attention to this—that while, according to the respondent's theory, the diaphragm is unnecessary, he uses it and sells it. Of course, my lord, I am not giving any admission upon that point, because we would require to go into that region, whether, if you take the material part of the combination, you would have to take the whole. If you take the substantial parts of the combination, you pirate the combination. But that really is not before us. I have here all the parts of the combination, and say that even possibly it is unnecessary to consider it; that they could do it with either the diaphragm or something else. Your lordship is not to consider that you have positively the first and the third of the three elements of the combination; and the one thing they say they have not is the middle one. Now you have had evidence from four very eminent electricians—Sir Frederick Bramwell, Sir Wm. Thomson, Mr. Imrie, and Professor Fleeming Jenkin, and also from Mr. Johnson, who has had great experience in inventions—that this is the thing; that it is not a question of being like it—it is the thing. What have you on the other side? Simply the evidence of two gentlemen, one of whom began his studies of telephony in 1876, and the other of whom seems to edit a very useful publication in London. I suppose they would be the first to say themselves that they could not get up their electrical knowledge and compare it with Sir William Thomson's, Professor Jenkin's, or perhaps that of the other gentlemen. Well, the theory is that Mr. Cooke's theory does not agree with Mr. Blyth's at all. He thought the mouthpiece, the diaphragm, and the cork were all needless and ridiculous superfluities here. He thought that if they hung these pieces of carbon in the box, there would be an equally good telephone. He said they were of no use except for the purpose of misleading the public. This diaphragm might have been a piece of painted cork! I don't think your lordship thought either Theiler or the respondent was of that opinion. Mr. Blyth is not of that opinion because he quite distinctly said this morning in answer to the question I put to him "Is the mouthpiece of any value?" "Of course it is," he says. "Does it collect the vocal impulses?" "Certainly," he says. "Is the diaphragm of any value?" "Of course it is; but the cork is not of so much value." And then he admitted, and I think it is very vital—what I apprehend he could not dispute—that by physical necessity that diaphragm operated in this instrument, and in that instrument you cannot help having a certain pull-and-push motion. Therefore, of the two witnesses examined for the respondent you have only one who will endeavour to reject these parts of the appliance. Mr. Blyth agrees with our witnesses and with Theiler, that these are material, and really it is astonishing that Theiler's diaphragm is regarded as immaterial, while Theiler himself considers it very material indeed.

(To be continued in our next.)

NOTES.

Change of Address.—Mr. R. Anderson, F.C.S., M.S.T.E., author of "Lightning Conductors, their History, &c.," requests us to state that his address is now No. 44, Essex Street, Strand, W.C.

Amendment of the Patent Laws.—We note the following in the Queen's Speech, read at the recent opening of Parliament: "Measures will also be proposed to you with respect to the consolidation and amendment of the laws affecting patents."

British Honduras and Cuba Submarine Telegraph Company, Limited.—The prospectus of the above company has been issued, with a capital of £120,000, and having for directors Sir James Carmichael (chairman), Charles W. Stronge, Esq., C.B., Alan Lambert, Esq., and Brodie Manuel de Zulueta, Esq.

The secretary and general manager is Alan E. Chambré, Esq., late controller of private wires department, General Post-office, and the consulting engineers are Sir Samuel Canning and Robert Sabine, Esq., C.E. The company has been formed for the purpose of purchasing and laying down between Belize, the capital of British Honduras, and Cape Antonio, in the Island of Cuba, a submarine cable 380 nautical miles in length, manufactured expressly by W. T. Henley's Telegraph Works Company, Limited, and now lying ready for shipment in the tanks of the said company. The prospectus states that the cable has been manufactured in accordance with the specification drawn up by Sir Samuel Canning and Mr. Sabine, who have tested the complete cable and certify the same as in accordance with the specification in every respect. It is calculated that the cable can be laid and be in working order by the end of April. We may add that this particular cable is manufactured of a material patented by Mr. W. T. Henley, and called "Henley's Patent Ozokerited Core." The advantages of india-rubber as regards its high insulation and low inductive capacity are well known, but hitherto this material has met with but partial success. By Mr. Henley's process the rubber is waterproofed by its peculiar treatment in curing and ozokeriting. The core so formed possesses many valuable properties which makes it eminently fitted for submarine telegraph purposes. This new insulating substance will bear exposure to extremes of heat and cold, or wet and dry, without injury. Unlike ordinary rubber core joints can be made with as much facility as is the case with gutta-percha. We believe that up to the present time only one cable of any length constructed with this material has been laid, and the success attending this fully justifies its future use as a competitor with gutta-percha. As we stated in our issue of January 14th, we can personally testify to the excellent qualities possessed by Henley's "Ozokerited India-rubber Core." The amount now offered for subscription is £60,000, in 6,000 preference shares of £10 each, with six per cent. *cumulative* interest.

The government of British Honduras, it appears, has guaranteed £1,000 per annum for 20 years. For further particulars we would refer our readers to the prospectus, which can be obtained at the company's temporary offices, 41, Moorgate Street, E.C.

Barraud and Lunds' System of Synchronising Clocks.—"An influential Company, having Messrs. Marshall, Jewell, Charles E. Mitchell, Morris F. Tyler and Robt. Wheeler Wilson on their board, and with all their capital privately subscribed, has just been formed in America, to be called 'The Standard Time Company.' Having carefully examined into the various systems of synchronising clocks in use both in America and Europe, the one in use in London, and known as Barraud and Lunds', has been adopted by them; a gentleman was specially sent over [to England to the patentees, negotiations were at once opened, communications cabled, and the whole concession concluded in a few days. The arrangements include the whole of the American Continent as well as the United States, and an effort will be made to bring about a concerted system of time signalling over the whole of the States; local affiliated companies are to be formed, and we shall probably soon hear of our transatlantic cousins having once more excelled us in an extensive exchange and utilisation of time signals as they have in their telephone exchanges.

"We are informed that Messrs. Barraud and Lunds, the patentees of the system of time signalling and clock synchronising so largely adopted in London, have appplied to the Postal Telegraph Department for the extension of their time exchange to telephone purposes. For some time they have been experimenting with the object of utilising their existing system for telephoning, which has resulted in a perfect success, and they now propose thus to formally duplicate and extend their system by which every telephone subscriber would be able to receive an hourly Greenwich time current by simply hanging his receiver on a hook in his telephone, marked 'time signal,' without any interference with the speaking power of the instruments. The proposals are under consideration at St. Martin's-le-Grand, where so beneficial an arrangement can hardly fail to receive due attention."

We are glad to hear of the success attending this very valuable and useful application of electricity, and Messrs Barraud and Lunds may be congratulated on the exceedingly good work they have performed during the last few years.

Mr. Jamieson's Paper on Incandescent Electric Lighting.—This paper, read before the Institution of Engineers and Shipbuilders in Scotland, by Mr. Jamieson, on the 20th of December last, and published in our issue of January 28th, did not lead to any further discussion.

Electrical Resistance and Co-efficient of Expansion of Incandescent Platinum.—The platinum pyrometer, under any form whatever, is as important for the measurement of temperatures above red heat as is the mercurial thermometer for ordinary temperatures.

The researches made on electrical resistance, the coefficient of expansion and the specific heat of platinum, show us what is still to be done in order to obtain with a little exactness the height of temperatures beyond 500 degrees.

Mr. E. L. Nichols, in a note read at the meeting of the American Association for the Advancement of Science, at Cincinnati, last August, made known the result of his experiments on the relations between these three factors. He determined with great precision the resistance and the length of a platinum wire between zero and its melting point. The results obtained are given in the following table. Connection between the lengths and resistances of a platinum wire between zero and near melting point:—

Resistances.	Lengths.	Resistances.	Lengths.
1·0000	1·00000	2·7821	1·00732
1·0410	1·00002	2·9696	1·00809
1·5071	1·00125	3·4151	1·01042
1·9000	1·00289	3·8750	1·01349
2·1212	1·00380	4·0303	1·01450
2·2934	1·00456	4·1248	1·01540
2·3035	1·00489	4·2447	1·01632

Dr. W. Siemens has published three formulæ for determining the variation of resistance of platinum with the temperature. The first (*a*) is deduced from calorimetrical comparisons with a ball of copper, supposing the specific heat of the copper to be constant. The two others (*b* and *c*) are deduced from measurements made with the air thermometer. These are the formulæ:—

$$r = 0{\cdot}039369\ \mathrm{T}^{\frac{1}{2}} + 0{\cdot}00216407\ \mathrm{T} - 0{\cdot}24127 \qquad (a)$$
$$r = 0{\cdot}0021448\ \mathrm{T}^{\frac{1}{2}} + 0{\cdot}0024187\ \mathrm{T} + 0{\cdot}30425 \qquad (b)$$
$$r = 0{\cdot}092183\ \mathrm{T}^{\frac{1}{2}} + 0{\cdot}00007781\ \mathrm{T} + 0{\cdot}50196 \qquad (c)$$

in which T represents the absolute temperature, and r the resistance of the wire. Sometimes also Benoît's formula is employed for determining high temperatures. This formula (*d*) is:—

$$r = 1 + 0{\cdot}002445\ t + 0{\cdot}000000572\ t^2 \qquad (d)$$

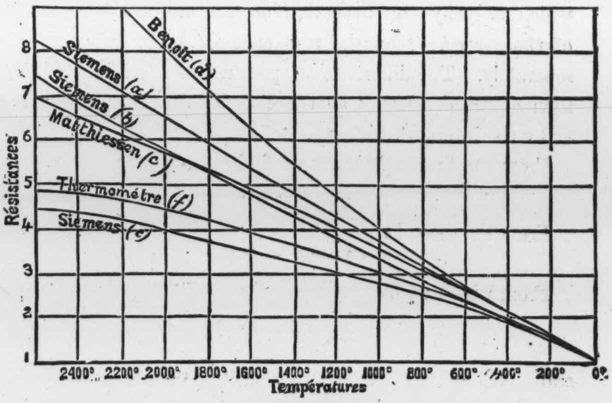
in which t is the temperature in degrees centigrade. When it is easier to measure the length of the wire than its electrical resistance in order to find the temperature t, Matthiessen's formula is used:—

$$l = l_0\,(1 + 0{\cdot}00000851\,t + 0{\cdot}0000000035\,t^2) \qquad (e)$$

We can also use the incorrect scale of the platinum thermometer, in which the relation between the temperature and the length is expressed by the formula:—

$$l = l_0\,(1 + 0{\cdot}00000886\,t) \qquad (f)$$

Such are the means actually at our disposal for calculating the temperature of a hot wire; it is not unimportant to know and to compare their correctness and the results obtained from them. Mr. Nichols has compared them by tracing the curves representing the different formulæ on one diagram (fig. 1), and on the same scale.



For the curves *e* and *f* the data given in the table have been used. A slight glance at the curves will suffice to show what little confidence can be placed in the formulæ and the results they give. The errors amount to several hundred degrees.

Mr. Nichols concludes from his experiments and from the results of the formulæ that these results cannot be accepted, because the formulæ are based upon inaccurate and inadmissible hypotheses, such as the constancy of the specific heat of copper and platinum, the constancy of the co-efficient of expansion of these metals, the accuracy of the very doubtful estimations of the boiling points of mercury, sulphur, zinc and cadmium, which points have served as data in the determinations. Moreover, the variations of resistance in the different specimens of platinum render the calculation of the temperature deduced from its electrical resistance applicable only to wires which are identical in nature, and to which the law of variation has been established. We cannot deduce the actual temperature of an incandescent platinum wire from its increase of resistance or of length, but we can only express this temperature in relation to the length or resistance. Taking into account the great variations of the electrical resistance of platinum wire according to the make, Mr. Nichols thinks it better to measure the increase in length of a wire than its electric conductivity.—*L'Electricien*, Feb. 1st, 1882.

THE INTERNAL RESISTANCE AND ELECTROMOTIVE FORCE OF ELECTRICAL MACHINES IN ACTION.—M. du Moncel presents a communication from M. G. Cabanellas on the measurement of the internal resistance and the electromotive force of electrical machines in action.

The method allows of determining these points without taking the machine to pieces, and with one machine only for each system. It may be explained as follows:—The machine works first as generator, at the rate of N revolutions per second, on a circuit of arbitrary resistance.

The intensity I and the difference of power e at the ends of the machine are observed. The machine is then made to work as a receiving motor, under the action of some external source; by means of a brake placed on the machine the intensity is brought to the value I of the first experiment, and the difference of power is made to vary until the machine turns at the rate of N revolutions per second, which is easily done by acting on the electromotive force of the source, or on the resistance of both, together or separately. The difference of power at the terminals, e', is then observed. Let E be the electromotive force required and r the internal resistance.

From the first experiment we find:

$$E = e + r\,I$$

From the second:

$$E = e' - r\,I$$

From which we deduce that:

$$E = \frac{e' - e}{2}$$

and

$$r = \frac{e' - e}{2\,I}$$

The internal resistance varies with the intensity of current and the speed of rotation.

M. Cabanellas attributes nearly the whole of this increase of resistance to the induced spirals or strands connected with the bars of the collector on which are produced, according to him, inductive phenomena; he does not think that the influence of the contacts of the brushes, when the machine is at work, is as great as the experiments of M. Lacoine seem to indicate. This is a very interesting technical point to which we shall have occasion to refer again shortly.—*L'Electricien*, Feb. 1st, 1882.

THE PATENT OFFICE.—During the past year the number of applications for letters-patent was 5,751, being an increase of 234 upon those of the year 1880. The records of the office show a steady and tolerably regular increase in the number of applications from the year 1852, when the Patent-law Amendment Act came into operation, down to the present time. In that year the number was only 1,211, but that was for a portion of the year only, the following year showing an advance to over 3,000, which, however, subsequently fell off; but by 1862 the number had risen to 3,490. During the following decade the progress was not quite so marked, the number for 1872 being 3,970. In 1876 the number was 5,069, the highest then reached; but there was a falling off of 120 in the succeeding year, since which time the numbers have risen to the figures first given as being the return for 1881.

NEW TELEGRAPH.—Adjutant-Major Gaumet, of the 27th Regiment of France, has invented an instrument called the "Telelogue," for signalling from a distance. As experience shows that familiar objects are the most easily distinguished, the signals consist of the letters of the alphabet and figures, which are silvered on a dead black ground and illuminated at night by lamps and strong reflectors. A powerful telescope alone constitutes the receiving instrument. For signalling to a distance of two and a half miles the whole apparatus weighs under five pounds; and with a more powerful telescope signals can be distinguished eight miles, and even farther in a clear atmosphere. For exploring new countries this invention is likely to prove of great service; for instance, the different members of a surveying party may be directed from a central point.—*Society of Arts Journal.*

ELECTRIC LIGHTING ON THE CONTINENT.—Since the Electrical Exhibition in Paris the greatest activity has been apparent amongst the promoters of the electric light in its various applications, and companies are being organised in Paris and elsewhere to work the various patents taken out on the Continent. Although many of these may almost be said to overlap each other (perhaps it would be more correct to say because they overlap each other), the holders of patents are careful not to court litigation, lest their inventions or improvements may fall into the public domain. A dispute is still pending between Mr. Edison and Mr. Maxim with respect to their incandescent lamps. How it will end, whether by a costly judicial suit or by a judicious compromise, it is impossible to foretell; but, meanwhile, every effort is being made to cover new ground. Amongst the most recently formed companies in Paris may be mentioned those for the working of the two last-named lamps, and another for the Gramme machine, although the patent in the latter case will soon expire. Two companies have been started on a minor scale in Belgium.—*Liverpool Journal of Commerce.*

THE FORTH CABLES.—The work of restoring communication between the north and south sides of the Forth began on the 1st inst., and notwithstanding the fact that the whole of the work was "tidal," it was completed early on the afternoon of the 4th. The laying of a new seven-wire cable between Granton and Aberdour was commenced on Wednesday, and on Thursday the work at the shore-ends was finished; on the succeeding day the four-wire cable between Granton and Burntisland was successfully grappled for, and on Saturday it was spliced and submerged. After coaling at Leith the *Morna* proceeded, on Tuesday last, to Rackwick, to lay a new shore-end.

TELEPHONE MONOPOLIES.—The German Minister of Posts and Telegraphs has followed the example of the English Postmaster-General, and asserted that the establishment of telephonic communication between houses is a part of the imperial monopoly.

THE ELECTRIC LIGHT.—The electric lighting of the entire French coast, and the improvement of the coast signals, form the object of a measure to be shortly submitted to the Chamber by the Commission of Maritime Ports.

THE UNITED TELEPHONE COMPANY *v.* MACLEAN.—An appeal is to be lodged against the judgment delivered in this case.

INFLUENCE OF THE FORM OF THE POLAR SURFACES UPON THE EXPLOSIVE POTENTIAL.—By M. J. B. Baille.—In a former communication I have indicated by what method I can measure the potentials corresponding to a determined explosive distance, between two planes, in air and under normal conditions. I have been led, in the course of my researches, to study the influence which the curvature of the polar extremities of the exciter may have upon the value of the potentials. I caused the spark to strike between two bodies of given form, respectively in communication with the two poles of an electrical machine, and I measured the potential in absolute value at the very moment of the spark.

One of the conductors alone was insulated, and connected to the attracting disc of the balance. It must be remarked that when a spark strikes between the two poles of a machine, that is to say, between two conductors insulated and charged respectively with equal quantities and of opposite signs, the potentials of each are generally different, and vary inversely as their capacities. It is therefore advantageous, in order to have only one measurement to make, to determine a spark between an electrified conductor and one in communication with the earth, the capacity of which is regarded as infinite.

I have studied two forms of exciters, concentric cylinders and spheres of different diameters.

I. When the spark strikes between two concentric cylinders, the potential depends not merely on the explosive length, but also on the diameters of the outer or inner cylinders: it increases with these diameters. M. Gaugain, in his researches on cylindrical exciters, has announced the law that the explosive density is independent of the outer cylinder. This law is not regularly verified, but it may give a sufficient approximation. It must be observed that the explosive density in concentric cylinders varies very little, whatever may be the diameter of the cylinders.

II. For spherical exciters, the one exterior to the other, the measurements which I have effected lead to the following results:—

1. For a given explosive length the potential is greatest when the spark strikes between two spheres of the same diameter.

2. It deviates so much the more from the maximum as the curvature of the poles is greater, and as the potential is more elevated.

3. I have found no well defined difference between the potentials corresponding to the same explosive distance, according as the electrified sphere is greater or smaller.

4. When the spark strikes between two equal spheres we may find for each explosive length a diameter such that the potential may be at a maximum. This diameter of the exciting sphere corresponding to the maximum is smaller the shorter the spark. Thus a spark of one millimetre requires a stronger potential to strike between two points than between two planes. For a spark of ten millimetres the contrary holds good.—*Comptes Rendus.*

CORRESPONDENCE.

TELEPHONE CIRCUITS.

To the Editor of THE ELECTRICAL REVIEW.

DEAR SIR,—I have been very much interested by Mr. Crossley's letter *re* the above, and by your foot-note to same in your issue of the 21st ult. From experiments I tried some nine months ago, I found that metallic circuits do *not* sucessfully eliminate induction, unless the two wires so forming the circuit be of the same length and equally exposed to the neighbouring and disturbing conductors. This is the case with the circuits belonging to the Parisian telephonic exchanges, every circuit is a metallic one, consisting of parallel wires, equal in length, and running together along with six other circuits in a small pipe of $\frac{3}{4}$ in. or so in diameter. Induction here is nil.

Where a metallic telephone circuit is to be built there is a great temptation to erect same on existing poles already stocked with busy telegraph circuits; now it is obvious that the chances of line faults occurring to a metallic circuit are double those to which a single wire would be exposed, and if in a metallic circuit so erected, either one of the two wires suffer from earth by actual or by weather contact, the circuit is immediately put under the influence, and at the mercy of the other external circuits. We know how disagreeable it is to work on such a circuit (which is now really only a single wire one, and suffers the same) if even the distance wire only be short, and if the distance be long it is impossible to work altogether.

I think that the outside construction work of long lines (3 to 40 miles) has been conducted too much on the old plan of erecting wire for post-office and general purposes, and without due reference to the requirements of telephone circuits. Suppose we have a line of poles carrying, say, three single wire telephone circuits—these wires each one foot apart, and that the length of such line is sufficient to enable a listener on No. 2 wire to hear *by induction* everything that may be said on Nos. 1 or 3. (I am supposing that the earths are perfect, and that there is no leakage from one insulator bolt to another.) I should now like to ask you what effect on this line the following alteration would make: simply increase the distance between each wire to two feet, *i.e.*, double the original distance. There must be *no* intermediate or idle wires between the two wires being tested, as they would only serve to carry the induction between the lines, the direction of the induced currents being reversed with every additional wire. Would *double* the original length of line now enable No. 2 to still hear the talking of Nos. 1 and 3, the distance between the wires being 2 feet throughout the line? These suppositionary circuits are all telephone circuits on their own poles, and not under any disturbing influence other than the other circuits on same poles. Of course, in short, local overhouse work, it is not necessary to keep the wires at such a distance apart, as they may be erected as closely as it is practically possible to do so. I am, yours truly,

Feb. 2nd, 1882. H.

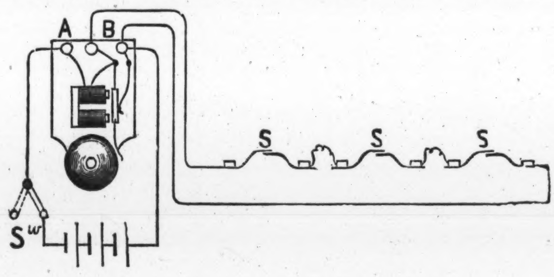
[The inductive effect between two wires varies inversely as the *square* of the distance between the two, consequently to *double* the distance will be to reduce the inductive effect to *one quarter*. Thus, although the listener on No. 2 wire would hear what is said on No. 1 or No. 3, the sounds would be very faint.—Edit. Elec. Rev.]

ELECTRIC BURGLAR ALARMS.

To the Editor of The Electrical Review.

Sir,—You will oblige me greatly, and probably interest many of your readers, if you will point out any simple method of protecting a dwelling-house from burglars by electricity.—Yours faithfully, B.

[The figure shows the general principle of a simple arrangement for indicating whether a door or window has been opened by any unauthorised person. s, s, s, are springs (a pair for each window or door) which are fixed in slight recesses cut in the lower parts of the frames of the windows or in the frame of the door, so that when these are closed the springs are pressed together, and the circuit between A and B completed. Under these circumstance the make and break portion of the trembler bell does not act, as it is short circuited, and the hammer keeps permanently attracted without vibrating; if, however, the circuit be broken between A and B by a window being opened, and the corresponding pair of springs ceasing to make contact with each other, then the make and break action of the bell can act, and the latter immediately sets off ringing. It is evident that any number of springs, s, s, s, can be included in the circuit. As the alarm system is usually only required during the night time, the switch s^{w} enables the battery to be cut off during the day time. The battery should be a Daniell of some form or other, a Leclanché would soon get exhausted by the current being kept continuously on. The closed circuit principle is much better than the open circuit for alarms, as it indicates at once whether everything is right, *i.e.*, whether all the contacts are good. A contact which works by "breaking" is very unlikely to fail, whereas a "making" contact cannot always be depended on. It is possible to arrange the contacts in several ways, for instance, a hall or passage might be protected by having a thin black thread stretched across it, the thread being attached to a spring so as to keep it against a contact; if a burglar or other unauthorised visitor were to walk up the passage or hall, he would break the thin thread, and thus allow the spring to fall away from its contact, and so cause the bell to sound. A thin blackened wire in the circuit would answer the same purpose, as the rupture of this wire would cause the required disconnection.—Edit. Elec. Rev.]



PROCEEDINGS. OF SOCIETIES.

PHYSICAL SOCIETY.—January 28th.

Dr. Stone, F.R.S., in the Chair.

New Member—Mr. W. Lant Carpenter.

Mr. T. Wrightson read a paper, by himself and Prof. W. Chandler Roberts, "On the Fluid Density of Metals." The results were obtained by the process described in a former paper to the Society, "On the Fluid Density of Bismuth." The mean results were—for copper, 8·217; lead, 10·37; tin, 7·025; zinc, 6·48; silver, 9·51; iron (No. 4 Foundry, Cleveland), 6·88. These results are slightly less than those given by Mallet's process, but they are sufficiently close. For bismuth the fluid density found by the authors is 10·055, which is slightly more than that given by Mallet's method (9·82). The authors consider their method very satisfactory. It consists in suspending a ball of the solid metal from a spiral spring, and allowing it to dip into a crucible of the same metal in a molten state. The movements of the spring as the ball melts are recorded by a pencil on a band of travelling paper.

Mr. C. Vernon Boys read a paper "On Apparatus for calculating Efficiency." The object of such machines is to automatically divide and continuously record the quotient of the speeds with which two things are turning. If the two things are the records of two of Boys' integrating machines (previously described to the society), one finding work put into and the other work sent out from any combination of mechanism, then the quotient gives the efficiency of the combination. If one measures work or current and the other time or turns of a machine, the quotient measures the value of horse-power per hour or current per turn. Mr. Boys described four machines of the kind acting on two principles, from which he names them logarithmic and harmonic dividers. They all derive their actions from motions of pure rolling. The simplest is made by hanging a magnetised steel reel on to a pair of iron cones, which are turned by integrators. The reel travels about and continuously shows the value of the quotient. Mr. Boys then read a paper "On a New Current Meter." The rate of a pendulum clock depends on gravity, and is proportional to the square root of the strength of gravity. That of a watch depends on the strength of the hair spring, and is proportional to the square root of its strength. The force due to an electric current is proportional to the square of the current of strength. Hence if part of an electric circuit is capable of vibrating under electromagnetic force the speed of vibration will be proportional simply to the current strength, for the square of the speed measures the force, and the force is proportional to the square of the current. If then such a contrivance takes the place of the balance of a pendulum clock the clock will measure electric currents instead of time. To keep the indications true, the maintaining power must be so contrived that the amplitude does not vary much, or the parts must be so arranged that the force is directly proportional to the displacement. Mr. Boys showed several ways of producing a controlling power. The first was a combination of solenoids, one passing through the other, and in which the force was proportional to the displacement. Being without iron, it applies to the case of alternating currents. In another, a small armature is mounted on the balance staff, and around it are the two poles of an electromagnet, which form part of the circuit. In a third form, which is unaffected by residual magnetism, two crescent-shaped pieces of iron forming the sides of the balance pass through two fixed solenoids. In all these cases the direction of the current does not matter.

The maintaining power may be an ordinary escapement driven in the usual way. It may also be independent of clockwork, an impulse being given to the balance electrically at each swing. A meter of this kind was shown in which the controlling power depends on iron crescents and solenoids, and in which a portion of the main current is shunted through secondary solenoids when the balance is in its neutral position, at which time a variation in the currents in the controlling solenoids has no effect in disturbing the period of oscillation. Such a meter is regulated by an adjustable weight if it goes too fast or slow. Being independent of gravity, it will work equally well anywhere.

Prof. John Perry thought Mr. Boys' devices very promising, and mentioned that Professor Ayrton and he had invented a very simple current meter not yet described. Dr. Coffin pointed out that electric clocks of a certain class were really current meters. Prof. Guthrie remarked that in Mr. Boys' meter practically no work was taken from the current. Reference was made by Dr. Stone and Mr. Lacky to Hipps' clocks, the former testifying to their efficiency.

Captain Abney, R.E., then exhibited some experiments on the phenomenon of phosphorescence. Balmain's luminous paint, calcium sulphide, and other substances, gave out a violet light after having been excited by daylight. Captain Abney found that when the spectrum was allowed to fall on an excited surface of Balmain's paint, the blue rays enhanced this violet light, and the red end of the spectrum extinguished it. This was shown to the meeting, and the red end of the spectrum appeared on the paint in well defined black bands. Similarly the light from an electric lamp passed through a sheet of red glass extinguished the phosphorescence. Captain Abney's researches further showed that there is a series of octaves in the blue end of the spectrum which refuse to quench the violet light. He found the mean wave-length of the rays exciting the phosphorescence to be 4,300. Prof. Guthrie also showed that calcium sulphide tubes glow in violet light.

NEW PATENTS—1882.

346. "Electric lamps and apparatus used in connection with electric lighting." R. E. B. Crompton. Dated Jan. 24.

359. "Electric lamps." J. N. Aronson. Dated Jan. 24.

361. "Electrical conductors or cables." W. R. Lake. (Communicated by H. A. Clarke.) Dated Jan. 24.

377. "Electric lamps." Sir C. T. Bright. Dated Jan. 25.

378. "Signalling apparatus for automatically signalling the approach of trains on railways." W. P. Thompson. (Communicated by W. W. Gray.) Dated Jan. 25.

380. "Automatic electro-magnetic piano and organ players." *Complete.* C. N. Andrews. Dated Jan. 25.

386. "Improvements in the construction of cores for cables for sending electric currents for telephone, telegraph, and other purposes, and in apparatus connected therewith." W. T. Henley. Dated Jan. 26.

388. "Improvements in transferring designs to surfaces particulary useful (among many other applications) for the production of electrotypes and printing plates and rollers." J. M. Moss. Dated Jan. 26.

392. "Improvements in obtaining light by electricity, and regulating the electric current for the same, and in the means or apparatus employed therein." W. P. Thompson. (Communicated by the Union Electric Manufacturing Company, Incorporated). Dated Jan. 26.

436. "Electric telegraph printing apparatus." J. Imray. (Communicated by J. M. E. Baudot.) Dated Jan. 28.

454. "Improvements in metallic brushes and in means for the local application of galvanic and magnetic currents." G. and E. Ashworth. Dated Jan. 30.

461. "Railway signalling apparatus." C. Barker. Dated Jan. 30.

489. "Electrical batteries for telegraphic, telephonic, and other purposes." E. Skrivanoff. Dated Jan. 31.

497 "Improvements in electro-magnets and armatures for the same, and mechanism connected therewith, for producing electro-magnetic motors and engines." G. Little. Dated Feb. 1.

513. "Electric meters." C. V. Boys. Dated Feb. 2.

538. "Electrical accumulators or secondary batteries." W. R. Lake. (Communicated by J. F. Barrier and F. T. De la Vernède.) Dated Feb. 3.

540. "Dynamo-electric and electro-dynamo machines." J. D. F. Andrews. Dated Feb. 3.

541. "Improved electric or magnetic motor." T. Morgan. (Communicated by J. C. Cuff and W. Judd.) Dated Feb. 3.

542 "Apparatus for regulating the transmission of electrical energy for heating, lighting, and other purposes." W. R. Lake. (Communicated by M. Levy.) Dated Feb. 3.

546 "Electric fog signalling on railways." E. Moxon. Dated Feb. 4.

559. "Printing-telegraph apparatus." W. R. Lake. (Communicated by S. Roos and F. Ostrogovich.) Dated Feb. 4.

563. "Arc electric lamps." A. J. Jarman. Dated Feb. 6.

578. "Electric lamps." B. J. B. Mills. (Communicated by W. M. Thomas.) Dated Feb. 7.

599. "Apparatus for operating railway signals." A. Gough. Dated Feb. 7.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1881.

2573. "Means for supporting and protecting electrical wires, &c." H. E. Newton. (A communication from abroad by C. A. Hussey and A. S. Dodd, of New York.) Dated June 14. 6d. The object of these improvements is to provide a simple and cheap means for supporting and protecting wires and other conductors used for electrical purposes, and a means that shall be out of the way, while affording convenient access to the wires or conductors. The improvements consist in the combination with the curb of the side-walk of a conduit affixed thereto, and receiving and protecting wires or other electric conductors.

2592. "Manufacture of telegraphic or telephonic conductors, &c." W. R. Lake. (A communication from abroad by H. A. Clark, of Boston, America.) Dated June 14. 6d. Relates to improvements in the manufacture of insulated telegraphic or telephonic conductors or cables, and to machinery therefor.

2606. "Electric accumulators." A. Muirhead. Dated June 15. 2d. Relates to improvements in electric accumulators or secondary batteries specially adapted for use in connection with dynamo-electric or magneto-electric machines (or other sources of electrical energy) in systems of electric lighting or of electrical transmission of power. The plates or electrodes of each element of such batteries are constructed of a number of sheets of lead-foil, tin-foil, or alloy of manganese and lead in foil, or other metal in foil, or very thin sheets. These are placed alternately like the plates of a condenser, that is to say, the first, third, fifth, &c., sheets are connected together to form one electrode, and the second, fourth, sixth, &c., sheets to form the other electrode of an element of the battery. These sheets are coated sometimes with a mixture of the sesquioxide and red oxide of lead formed into a paste with solution of sulphuric acid in water, or sometimes with a paste composed of a mixture of red oxide of lead and red oxide of manganese; or the sheets are coated alternately with a paste composed of a mixture of red oxide of lead and peroxide of manganese, and with a paste consisting of red oxide of lead only; or there is interposed between the sheets either acetate or nitrate of lead moistened with solution of sulphuric acid in water; and there is also interposed between each sheet of foil, coated in any of the above ways, and the next a thin sheet of a permeable material of somewhat high specific resistance, such as tissue paper soaked in glycerine, or vegetable parchment. (*Provisional only.*)

2607. "Electric bells, &c." W. P. Granville. Dated June 15. 2d. Has for its object improvements in electric bells, applicable also to relays and other electrical mechanism. In electric bells it is usual to employ a stationary electro-magnet which alternately attracts and releases a moving armature in connection with a hammer which is thus caused to strike upon a bell. According to the new invention the use of any separate armature is dispensed with, and the electro-magnet is constructed that one of its poles may be capable of movement to and from the other pole. (*Provisional only.*)

2612. "Electric lamps, &c." William Crookes. Dated June 15. 4d. Has for its object improvements in the construction of incandescent electric lamps and apparatus for electric lighting. The inventor takes paper, cotton, linen, or cellulose in other convenient form, and having purified it by means of hydrofluoric acid, treats it with a solution of ammonical oxide of copper, which, as is well known, has a solvent effect upon cellulose. The prepared paper is punched out to the form of a horse shoe or other suitable form, and then carbonised.

2618. "Governing electric machines." John Jameson. Dated June 16. 2d. Consists in changing the speed of running of the dynamo machine by an electro-magnet in circuit with the machine, the electro-magnet releasing or holding certain clutches. (*Provisional only.*)

2703. "Electric appliances for moving tram cars, &c." J. Richardson. Dated June 20. 2d. The object of this invention is driving tram and other cars by the use of an electric motor and secondary batteries, and for utilising the momentum of said cars in descending inclines or stopping for producing electricity and partially recharging cells. (*Provisional only.*)

2770. "Electrical resisting mediums." R. H. Courtenay. Dated June 24. 2d. Relates, firstly, to the preparation of carbon and mediums with carbonaceous surfaces, some of which mediums become wholly carbonised by the action of the electric current. Secondly, in forming carbon into threads. (*Provisional only.*)

4420. "Telephonic and telegraphic apparatus and circuits." Sydney Pitt. (A communication from abroad by W. R. Patterson and C. E. Scribner, of America.) Dated Oct. 11. 6d. One object of this invention is to provide for each subscriber or member of a telephone company a means of communication directly with the listening attendant and central office at all times for the purpose of obtaining a connection or disconnection to enable the central office manager to regulate at will the number of subscribers to be taken care of by a single attendant, and an improved method of notifying the attendant of a call when he is not listening at his telephone.

4421. "Apparatus for use upon telephone lines." G. Pitt. (A communication from abroad by C. E. Buell, of America.) Dated Oct. 11. 10d. Relates, first, to means for signalling to one of several stations upon the same telephone line without producing a signal at the others. Second, to an arrangement of the lines connecting several stations with one another, or with the apparatus at the central station of a telephone exchange system, the object being to increase the facilities for telephone communication in locations where the telephones are in frequent use. Third, to the apparatus used at the central station, and constitutes an improvement upon that class of central station switches in which the operations of connecting and disconnecting the various lines are automatically performed from the outlying stations, without the assistance of attendants at the central station. Fourth, to an improved method of charging the telephone lines during oral communication, for the purpose of increasing the volume and distinctness of the sounds, and for the further purpose of enabling speech to be transmitted to greater distances, and to also, if desirable, make it possible to dispense with the use of induction coils.

CITY NOTES.

OLD BROAD STREET.

ANGLO-AMERICAN TELEGRAPH COMPANY.

THE report of the directors of this company, to be presented to the ordinary general half-yearly meeting, being held as we go to press, states that the total receipts from the 1st July to the 31st December, 1881, including a balance of £23,545 19s. 4d. brought forward from the last account, amount to £244,412 11s. 3d. The traffic receipts show an increase of £4,593 as compared with the corresponding period of last year. The total expenses of the half-year, including repair of cables, income tax, &c., as shown by the revenue account, amount to £59,600 18s. 3d. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £75,000 to the renewal fund, leaving an available balance of £109,811 13s. Interim dividends of 15s. per cent. on the ordinary stock, and 30s. per cent. on the preferred stock, free of income tax, were paid on the 1st November last, absorbing £52,500, leaving a balance of £57,311 13s., out of which the directors recommend the proprietors to declare final dividends, free of income tax, of 15s. per cent. on the ordinary stock, 10s. per cent. on the preferred stock, and £1 per cent. on the deferred stock, amounting altogether to £52,500, making a total distribution for the year ended the 31st December, 1881, of 3½ per cent. upon the ordinary stock, 6 per cent. upon the preferred stock, and 1 per cent. on the deferred stock, leaving a balance of £4,811 13s. to be carried forward to the next account. The company's repairing steamship *Minia* has been employed during the half year in the repair of the St. Pierre-Duxbury cable, broken on the 6th August, the St. Pierre-Sydney cable, broken on the 4th July, and the Brest-St. Pierre cable, in which a fault appeared on the 29th October at 177 miles from St. Pierre, in 200 fathoms of water. The severe gales which prevailed in the months of November and December did great damage to cable property in general, and caused considerable loss of traffic receipts. With the exception of the shore-end of the 1874 cable, which was broken at about one mile from the Irish Coast on the 22nd November last, the whole of the cables and plant of the company are in good working order and condition. The restoration of communication upon this cable has been intrusted to the Telegraph Construction and Maintenance Company, and active measures are now in progress for its prompt repair. The American Telegraph and Cable Company, established at New York by Mr. Jay Gould and his party, have not yet completed the laying of their two cables between Nova Scotia and Cornwall. The first cable was announced as having been successfully laid and completed on the 8th July last, and messages sent through it to and from the President of the United States were published in the newspapers. The new company's office in London was not opened, however, until the 15th September, and it only remained opened for the transmission of public messages until the 19th September, when it was closed in consequence of interruption of communication by the cable, and has not since been re-opened. As announced in the last half-yearly report, the board decided, with the concurrence of the directors of the Direct United States Cable Company and the Paris and New York Telegraph Company, to reduce the tariff for messages between the United Kingdom and Yew York and Canada to one shilling per word from the 1st August last. The net receipts of the three companies interested, at the reduced rate, have averaged £1,674 per day for the five months, ended the 31st December, 1881, including Sundays and holidays, which sum, as compared with the total average net earnings under the same tariff in 1877, shows an increase of £801 per day, equal to about 92 per cent. The experience which has been gained since the introduction of the one shilling per word tariff on the 1st August last, is not sufficient to enable the directors to determine, whether the present low rates for the transmission of messages across the Atlantic can be profitably maintained, and it will be obvious to the proprietors, that the policy which was adopted by the boards of the three associated companies, after full consideration of the whole subject, cannot be departed from in the present critical position of their relations with connecting companies in the United States of America. An explanation of this position was given in the last half-yearly report, and a discussion took place at the general meeting held on the 5th of August, upon the measures taken for the protection of the company's interests. The board continue to give their most careful attention to these matters. In accordance with the articles of association, two directors of the company, the Right Honourable Viscount Monck and Charles Crapelet, Esq., retire at this meeting, and being eligible, offer themselves for re-election. Mr. Joshua Dean and Mr. Francis Glass, the auditors, retire, and offer themselves for re-election.

THE INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

THE directors' report for the year ending December 31st last, states that the net profit on the company's business for the past year, as shown in the annexed accounts, is £77,226 1s. 7d. Adding £8,280 3s. 8d. brought forward from 1880 and £7,820 12s. 6d. profit on securities realised and dividends, and deducting £15,600 interim dividend paid in July, there remains a disposable balance of £77,726 17s. 9d. Of this balance the directors have added £25,000 to the reserve fund, raising it to £100,000; and they now recommend the distribution of £1 per share, amounting to £31,200, making a total dividend for the year of 15 per cent., as against 12½ per cent. for 1880, free of income tax, carrying forward £21,526 17s. 9d. to the credit of the current year. The general sales at Silvertown and at Persan, show an increase of about £21,500 compared with 1880, the company having been busy in most departments at both works. By improvements which have increased the facilities at Persan, the company has been enabled to undertake contracts for subterranean telegraph cables in France. In August the directors obtained a contract from the Central and South American Telegraph Company, of New York, for 3,082 nautical miles of cable to connect Vera Cruz in Mexico with Callao in Peru, and with stations at the principal Central and South American ports. The Vera Cruz section was sent out in this company's steamship *International*, and was successfully laid last month. The company's steamship *Dacia*, with 813 miles of cable to be laid in the Pacific, reached Callao last month, and is at work. The steamship *Silvertown* (late the *Hooper*), which the directors purchased in November, will sail for the Pacific this month with the remainder of the cable. These cables will unite those made and laid by this company for the Mexican and West Coast of America Telegraph Companies, the whole consisting of about 5,400 miles, and will complete an important direct line between Valparaiso and New York. Of the other cables made by the company during the year may be mentioned 300 miles for the West India and Panama Telegraph Company, 70 of heavy cable for the Great Northern Telegraph Company, and shorter lengths for the Submarine and Direct Spanish Telegraph Companies. The company's staff and steamships were engaged in cable repairs during the year for the International Ocean Telegraph Company of New York and for the Postal Department of Her Majesty's Government. Dr. Beattie, who retires by rotation, offers himself for re-election as a director.

CONSOLIDATED TELEPHONE CONSTRUCTION AND MAINTENANCE COMPANY (LIMITED).—The Stock Exchange Committee have ordered 45,835 fully paid vendors' shares in this company to be quoted in the official list.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotations. Feb. 8.	Busines Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	4	9 - 9½	
		Do. Do.	10	22 - 23	22.3.2
150,000	1	Electric Light and Power Generator Co.	1	1 - 1¼	$1\frac{3}{16}$
		TELEGRAPHS.			
2,116,400*l.*	Stk.	Anglo-American, Limited	100	50 - 51	50⅝.¾
2,441,800*l.*	Stk.	Do. Preferred } Def'd. receiving no div. until	100	78 - 79	78½.¼.½
2,441,800*l.*	Stk.	Do. Deferred } 6 p. c. has been paid to Pref.	100	21 - 22	21¼
130,000	10	Brazilian Submarine, Limited	10	11 - 11¼	11⅛
16,000	10	Cuba, Limited	10	8½ - 9	8½ xd.
6,000	10	Do. 10 per cent. Preference	10	15½ - 16½	xd.
13,000	10	Direct Spanish, Limited	9	5 - 5½	
6,000	10	Do. 10 per cent. Preference	10	14½ 15½	
65,000	20	Direct United States Cable, Limited, 1877	20	10¼ - 10½	10½
100,000*l.*	100	Do. 6 per cent. Debenture, repayable 1884	100	100 -103	
380,000	10	Eastern, Limited	10	9⅞ - 10⅛	
70,000	10	Do. 6 per cent. Preference	10	12½ - 12¾	
232,000*l.*	100	Do. 6 do. Debentures, repayable Oct. 1883	100	101 -104	
200,000*l.*	100	Do. 5 do. do. Aug. 1887	100	98-101	100.100.¼.⅜.1.110.¾xd.
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	102 -107	xd.
199,750	10	Eastern Extension, Australasia & China, Limited	10	10⅞ - 11⅛	
320,000	100	Do. 6 p. c. Debentures, repayable Feb. 1891	100	105 -109	xd.
500,000	100	Do. 5 p. c. (Australian Gov. Subsidy) Deb. 1900	100	101 -104	
140,000	100	Do. do. registered, repayable 1900	100	101 -104	
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 -105	
254,300*l.*	100	Eastern and South African Limited 5 per cent. Mort. Deb. Registered redeemable 1 Jan 1900	100	100 -103	
345 700*l.*	100	Do. do. do. To Bearer	100	100 -103	
22,050	10	German Union Telegraph and Trust, Limited	10	9¼ - 9¾	9¾ xd.
163,390	10	Globe Telegraph and Trust, Limited	10	6 - 6¼	$6\frac{1}{16}$*.¼.$\frac{3}{16}$
163,209	10	Do. 6 per cent. Preference	10	12¼ - 12½	12⅜.¼
125,000	10	Great Northern	10	11½ - 12	
100,000*l.*	100	Do. 5 per cent. Debentures	100	100 -103	101½
31,200	10	India-Rubber, Gutta-Percha and Telegraph Works	10	..	
100,000	100	Do. 6 per cent. Debentures, 1886	100	..	
17,000	25	Indo-European, Limited	25	28 - 29	
38,148	10	London Platino-Brazilian, Limited	10	4¾ - 5¼	
12,000	10	Mediterranean Extension, Limited	10	2¼ - 2¾	
8,200	10	Do. 8 per cent. Preference	10	9¼ - 9¾	
9,000	8	Reuter's, Limited	8	12¼ - 12¾	
280,000	Stk.	Submarine	100	270 -280	
58,225	1	Do. Scrip	1	2⅜ - 2⅝	
4,200	Cert.	Submarine Cables Trust	100	97 -100	
37,350	12	Telegraph Construction and Maintenance	12	28½ - 29½	
150,000	100	Do. 6 per cent, Bonds, 1884	100	101 -105	
186,750	5	Do. 2nd Bonus Trust Cert.	5	1⅜ - 1⅝	
30,000	10	West Coast of America, Limited	10	4½ - 5	
150,000	100	Do. 8 per cent. Debentures	..	..	
69,910	20	Western and Brazilian, Limited	20	8⅜ - 8⅝	8¾.⅞.½.⅝
200,000*l.*	100	Do. 6 per cent. Debentures "A" 1910	100	105 -110	xd.
2,500	100	Do. 6 p.c. Mort. Deb. series B of '80, red. Feb., 1910	100	97 -100	xd.
1,500	$1,000	Western Union of U. S. 7 p.c. 1 Mort. (Building) Bds.	$1,000	123 -128	
1 030,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	104 -107	
88,321	10	West India and Panama. Limited	10	1½ - 1¾	
34,563	10	Do. 6 per cent. 1st Preference	10	7¾ - 8¼	
4,669	10	Do. 6 do. 2nd do.	10	6 - 6½	6
		TELEPHONES.			
154,165	1	Con. Telephone & Maintenance, Ld. Nos. 1 to 154,165	1	1⅛ - 1⅜	1⅜
200,000	1	Oriental Telephone Co.	½	⅜ - ⅝	
100,000	5	United Telephone Co.		12 - 12½	

* Exceptional amount at special price.

TRAFFIC RECEIPTS.

Cuba Submarine Telegraph Company. January, £2,800 against £2,527 in corresponding period of 1881; for the month of November, estimated at £2,600, realised £2,431.

Direct Spanish Telegraph Company, Limited. January, £2,055 against £1,506 in corresponding period of 1881.

Eastern Telegraph Company. January, £53,648 against £47,445 in corresponding period of 1881, being an increase of £6,203.

Eastern Extension Company. January, £33,129 against £29,434 in corresponding period of 1881, being an increase of £3,695.

Great Northern Telegraph Company. January, £16,960 against £17,353 in corresponding period of 1881, and £17,297 in 1880.

The Western and Brazilian Telegraph Company, Limited. January 27th, £2,566. February 3rd, £2,495, both after deducting the "fifth" of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The West India and Panama Telegraph Company, Limited. The estimated traffic receipts for the half month ended the 15th January are £2,115 as compared with £2,192 in the corresponding period of 1881, and for the half month ended 31st January, £2,741 as compared with £2,139 in 1881. The October receipts, estimated at £3,848, realised £3,791.

EDWARD PATERSON,
TELEGRAPH & ELECTRICAL ENGINEER,
St. Paul's Works—76, LITTLE BRITAIN, LONDON, E.C.,
AND
European Telegraph Works—POWNALL ROAD, DALSTON.
(PARIS AGENTS—E. & S. DELEVINGNE, 8, RUE MARTEL, PARIS.)
Prize Medal, International Electrical Exhibition, Paris, 1881.
MANUFACTURER OF
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AND ALL ACCESSORIES FOR
TELEPHONE EXCHANGES.
Electric Signals for Mines, Houses, Ships, &c. Block and Needle Instruments for Railways.
Silk and Cotton covered Wires; Rubber covered Wires for Electric Signals; Electric Light Leads.
THE DOUBLE INDUCTION MOTOR FOR SEWING MACHINES, &c.
Batteries, Insulators, and other Telegraph Stores. Continuous Copper Band Lightning Conductors.

AYRTON & PERRY'S
Instruments for Electric Light Measurements.
Ammeter.
Ohmmeter.
Voltmeter.
Electric Power Meter.

AYRTON & PERRY'S
Dynamometer Coupling.
Dispersion Photometer.

THE GOWER-BELL
LOUD SPEAKING TELEPHONE.
As adopted by
Her Majesty's Government.

ELECTRIC LIGHT LEADS, GUTTA-PERCHA, INDIA-RUBBER, COMPOUND BRAIDED COTTON, SILK COVERED WIRES.

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ELECTRICAL WIRE MANUFACTURERS,
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LONDON.
ESTABLISHED 1870.]

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GERMAN SILVER WIRES FOR HIGH RESISTANCES, FLEXIBLE CORDS, TELEPHONE WIRES, &c., &c. MULTIPLE, AERIAL, AND SUBTERRANEAN CABLE WIRES TO ANY SPECIFICATION.

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Works: Silvertown, Essex; Persan-Beaumont, France.

TELEGRAPH ENGINEERS & MANUFACTURERS

OF

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